

**HYDRAULIC REPORT
PROJECT: FLH 0711(3)
17-MILE ROAD**

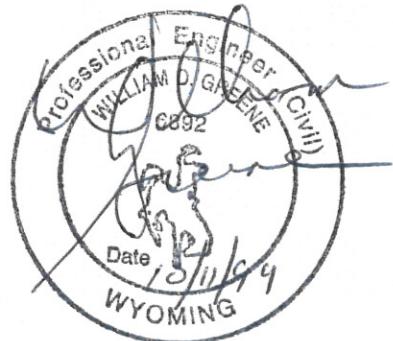


**MILL CREEK
SUB-AGENCY DITCH**

Prepared For The



By



**WYOMING DEPARTMENT OF TRANSPORTATION
PROJECT No. FLH 0711(3) – 17-MILE ROAD
MILL CREEK & SUB-AGENCY DITCH HYDRAULIC REPORT
FREMONT COUNTY**

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I. INTRODUCTION

The Wyoming Department of Transportation (WYDOT) is proposing roadway reconstruction along the 17-Mile Section of Fremont County Route 334. In conjunction with road construction, three drainage structures exist along this project, which require a hydraulic analysis for replacement purposes. These crossings include Mill Creek (Station 6+604), The Little Wind River (Station 14+725), and the Sub-Agency Ditch (Station 15+380). The following report summarizes the hydraulics associated with Mill Creek and the Sub-Agency Ditch.

Mill Creek is located in Section 7, Township 1 South, Range 2 East (See Appendix A – Site & Vicinity Maps: Figure 1). The Sub-Agency Ditch is located in Section 12, Township 1 South, Range 2 East (See Appendix A - Site and Vicinity Maps: Figure 2). Both structures are within the Wind River Indian Reservation near Riverton, Wyoming.

II. HYDROLOGY

MILL CREEK:

Flowrate estimation for Mill Creek was determined using the U.S.G.S. Publication, Water-Resources Investigations Report 88-4045, *Streamflows in Wyoming*. As outlined in this report, Wyoming's hydrological climate is divided into three distinct regions, which include the Mountainous Region, Plains Region, and High Desert Region. Each hydrologic region comprises two independent methods for estimating peak flowrates. Type I equations were developed by correlating physical and climatic characteristics of a drainage basin with those characteristics of a stream within the same or similar basin. Basin characteristics include variables relating to average annual precipitation, geographic factors, basin slope, drainage area and are referred to as cause and effect parameters because they directly affect the outcome of flows in an area. In contrast, Type II equations utilize channel width as a means of relating stream features to flow characteristics. Type II equations are not considered cause and effect variables, but are referred to as resultant-effect variables because the channel width is a reflection of past flows.

Conveyance to Mill Creek begins near Latitude $42^{\circ} 52.5'$ and Longitude $109^{\circ} 00'$ within the Mountainous Region near the hydrological boundary separating the Mountainous and High Desert Region. The majority of drainage area contributing flow to Mill Creek is within the High Desert Region and reflects High Desert characteristics more than the Mountainous Regions attributes. However, final flowrates will reflect both hydrologic regions.

A United States Geological Survey (USGS) gauge site on Mill Creek is positioned at a latitude of $42^{\circ} 56' 50''$ and a longitude of $108^{\circ} 48' 29''$ (See Appendix C – Hydrology: *Mill Creek Hydrology*). Station Number 06230190 referred to as *Mill Creek Above Ray Lake Outlet Canal, Near Fort Washakie* has a contributing drainage area of 25.43 km^2 (15.8 miles^2). The remainder

of the drainage area between Gauge 06230190 and the proposed crossing was determined using USGS 7.5 Minute Series Quadrangle Maps. USGS Mapping reveals that in the upper reaches of drainage to Mill Creek, flow from some tributaries is integrated into irrigation ditch flow running perpendicular to runoff, thereby reducing drainage into Mill Creek. Estimated drainage area for this intermediate section is 25.12 km^2 (9.7 miles 2). When combined with the gauge drainage area of 25.43 km^2 (15.8 miles 2), the total drainage area contributing runoff to the Mill Creek Crossing is estimated to be 66.04 km^2 (25.5 miles 2). Information, other than the drainage area, from Gauge Number 06230190 was not used for flowrate estimation because of the short time period in which data was retrieved. Available information from this gauge site is based on data from 1990 to 1996. Utilizing a Log Pearson Type III or similar analysis requires a more extensive history of peak flowrate information.

Flowrates based on criteria associated with Type II Equations (Channel Width) were not used in this analysis because cross sectional information was limited to one upstream and one downstream cross section. In order to estimate channel width, an adequate sample of channel widths should be evaluated. Since information from two cross sections was not deemed extensive enough, Type I (Basin Characteristics) was only used in estimating flowrates for Mill Creek.

A WYDOT Reconnaissance Report, dated April 14, 1995, assigned a Functional Classification of Rural Major Collector to this stretch of roadway. Referencing this classification to WYDOT Operating Policy 18-6 indicates the proposed drainage structure for Mill Creek will be designed to convey the 25-Year Flood. Developed upstream property of Mill Creek is minimal with only a few small hay fields. The estimated 100-Year Flood will be analyzed as a basic flood to determine flood plain boundaries and impacts to surrounding area.

Hydrologic variables associated with Type I (Basin Characteristics) equations include the following for the High Desert Region:

- Drainage Area = 66.04 km^2 (25.5 miles 2).
- Average Annual Precipitation = 304.80 mm (12 inches).
- Geographic Factor = 1.0.

Mountainous Region hydrologic variables associated with Type I (Basin Characteristics) equations include the following:

- Drainage Area = 4.71 km^2 (1.82 miles 2).
- Average Annual Precipitation = 304.80 mm (12 inches).



Flowrate estimation for Mill Creek was finalized by utilizing the weighted average for both regions (*See Appendix C – Hydrology: Mill Creek Hydrology*). Weighted averages produced a Q_{25} flowrate of $28.74 \text{ m}^3/\text{s}$ (1015 cfs) and a Q_{100} flowrate of $49.47 \text{ m}^3/\text{s}$ (1747 cfs).

SUB-AGENCY DITCH:

Conveyance along the Sub-Agency Ditch is used for irrigation purposes for surrounding farm and ranch land. Flow is fed from the Little Wind River approximately 2568 meters (8426 feet) upstream of the crossing.

Water Right information for the Sub-Agency Ditch was obtained from the Wyoming State Engineer's Office. State Engineer's Records indicate that the Sub-Agency Ditch is allotted a conveyance of $3.98 \text{ m}^3/\text{s}$ (140.74 ft³/s) (*See Appendix C – Hydrology: Sub-Agency Hydrology*). Conversations with the Shoshone and Arapaho Tribes Office of the Tribal Water Engineer suggest that the Sub-Agency Ditch, above the proposed crossing, does not integrate surface runoff. Therefore, the design flood for the Sub-Agency Crossing will be $3.98 \text{ m}^3/\text{s}$ (140.74 ft³/s), and for the basic flood, the water right of $3.98 \text{ m}^3/\text{s}$ (140.74 ft³/s) will be doubled to $7.96 \text{ m}^3/\text{s}$ (281.50 ft³/s).

Table 1 summarizes flowrates for Mill Creek and the Sub-Agency Ditch.

Table 1 - MILL CREEK & SUB-AGENCY FLOWRATE SUMMARY

CROSSING	DESIGN FLOOD m^3/s (ft ³ /s)	BASIC FLOOD m^3/s (ft ³ /s)
MILL CREEK	$Q_{25} = 28.74$ (1015)	$Q_{100} = 49.47$ (1747)
SUB-AGENCY DITCH	$Q_{WR} = 3.98$ (140.74)	$Q_{2(WR)} = 7.96$ (281.50)

Q_{WR} : Adjudicated Water Right provided by the State Engineers Office.

$Q_{2(WR)}$: 2 times the Adjudicated Water Right.

III. HYDRAULICS

MILL CREEK:

Mill Creek is a meandering channel encompassed in a basin with a valley slope of approximately 0.00636 m/m (ft/ft) and an overall channel slope of 0.00442 m/m (ft/ft). Flow both upstream and downstream of the proposed crossing reveals meandering is a prominent characteristic of Mill Creek. However, near the crossing (approximately 122 meters (400 feet) upstream and downstream) meandering is significantly reduced. Estimated sinuosity for Mill Creek in the vicinity of the proposed crossing is 1.44. Channel banks are well vegetated showing no bank cutting or other erosive characteristics. Mill creek appears reasonably stable (*See Appendix B – Photographs: Mill Creek Photographs*).

The existing drainage structure at the Mill Creek Crossing is a Corrugated Steel Elliptical Pipe measuring approximately 2845 mm (9.33 feet) by 1905 mm (6.25 feet) (*See Appendix B –*

Photographs: Mill Creek Photographs). Apex Surveying, the lead design consultant for Project FLH-0711(3), has indicated the Shoshone and Arapaho Tribes Office of the Tribal Water Engineer prefers a Pre-Cast Reinforced Concrete Box Culvert (RCBC) for replacement. However, for comparison and economic purposes, RCBC's and other pipe structures will be evaluated hydraulically for this site. The structural engineer in the structure selection process will determine the most feasible structure for the Mill Creek Crossing based on options provided in this report.

The following information was used for hydraulic analysis purposes.

- Slope through the proposed RCBC is 0.00437 m/m (ft/ft).
- Top of grade elevation at crossing is estimated to be 1596.09 meters (5236.51 feet).
- Assume 0.40 meters (1.31 feet) of Roadway Surfacing Depth.
- Assume 0.610 meters (2.00 feet) of cover.
- Maximum culvert height is estimated to be 1.83 meters (6.0 feet).
- Flowline elevation through the proposed and existing structures is 1593.15 meters (5226.87 feet).

Incorporating the above information with surveyed cross sections, a hydraulic analysis was completed using the computer program CDS (Culvert Design System). Analysis studied the existing hydraulics as well as proposed alternatives for Mill Creek. Table 2 summarizes the existing hydraulics associated with the Mill Creek Crossing.

Table 2 - MILL CREEK EXISTING STRUCTURE HYDRAULICS

STRUCTURE mm x mm (ft) x (ft)	HW ₂₅ DEPTH m / (ft)	V ₂₅ OUTLET m/s / (ft/s)	OUT ₂₅ DEPTH m / (ft)	HW ₁₀₀ DEPTH m / (ft)	V ₁₀₀ OUTLET m/s / (ft/s)	OUT ₁₀₀ DEPTH m / (ft)
1 - 2845 x 1905 (1 - 9.33 x 6.25)	3.35 (11.00)	4.15 (13.60)	1.46 (4.80)	3.72 (12.20)	3.75 (12.30)	1.89 (6.20)

NOTE: HW = HEADWATER, TW = TAILWATER

Analysis shows the existing structure does not convey the design flood of 28.74 m³/s (1015 ft³/s), therefore, it does not meet the WYDOT drainage criteria outlined in WYDOT Operating Policy 18-6. Referencing *Appendix D – Hydraulics: Mill Creek Hydraulics*, analysis reveals that approximately 13.27 m³/s (468.70 ft³/s) overtops the road grade at the Mill Creek Crossing during a 25-year flood with the existing structure in place. For the basic flood of 49.47 m³/s (1747 ft³/s) nearly 33.16 m³/s (1171 ft³/s) will overtop the grade under existing conditions.

Information from the Tribal Water Engineer's Office suggests that past spring rains have produced flowrates, which exceeded the capacity of the existing structure. A recent example of

this observation was spring rains in April and May of 1999 produced large backwater problems at the Mill Creek Crossing.

Having analyzed the existing structure, analysis pursued possible alternatives, which will convey the estimated design flood as well as minimize 100-year flood impacts. Table 3 summarizes the proposed alternatives for Mill Creek.

Table 3 - MILL CREEK PROPOSED STRUCTURE HYDRAULICS

STRUCTURE mm x mm (ft) x (ft)	HW ₂₅ DEPTH m / (ft)	V ₂₅ OUTLET m/s / (ft/s)	OUT ₂₅ DEPTH m / (ft)	HW ₁₀₀ DEPTH m / (ft)	V ₁₀₀ OUTLET m/s / (ft/s)	Q ₁₀₀ OVERFLOW m ³ /s / (ft ³ /s)
2-2400 x 1500 RCB 2-8.0 x 5.0	2.68 (8.80)	3.87 (12.70)	1.43 (4.70)	3.41 (11.20)	4.39 (14.40)	16.50 (582.70)
2-2400 x 1800 RCB 2-8.0 x 6.0	2.47 (8.10)	3.87 (12.70)	1.46 (4.80)	3.35 (11.00)	4.11 (13.50)	12.43 (439.00)
3-1500 x 1800 RCB 3 - 5.0 x 6.0	2.62 (8.60)	3.90 (12.80)	1.55 (5.10)	3.38 (11.10)	4.15 (13.60)	14.37 (507.60)
3-1800 x 1800 RCB 3 - 6.0 x 6.0	2.35 (7.70)	3.63 (11.90)	1.40 (4.60)	3.26 (10.70)	4.02 (13.20)	8.69 (306.80)
3 - 1800 RCP 3 - 6.0	2.53 (8.30)	3.99 (13.10)	1.49 (4.90)	3.38 (11.10)	4.54 (14.90)	13.64 (481.60)
4 - 1650 CMP 4 - 5.5	2.56 (8.40)	3.51 (11.50)	1.40 (4.60)	3.41 (11.20)	3.75 (12.30)	15.51 (547.80)
2 - 2700 x 1650 ECP 2 - 8.9 x 5.7	2.62 (8.60)	3.93 (12.90)	1.46 (4.80)	3.41 (11.20)	4.51 (14.80)	15.14 (534.60)

(See Appendix D – Hydraulics: Mill Creek Hydraulics)

Proposed structures will convey the design flood while reducing headwater elevations an average of approximately 0.81 meters (2.64 feet) from existing conditions. Although analysis shows that the Q₁₀₀ flood will overtop the roadway, overflow is significantly less than existing conditions. Impacts associated with the proposed structures are estimated to be less than those surmised for the existing structure.

Debris consists of brush and other small vegetation, which should not pose significant clogging concern to the proposed RCBC's. Cross sectional area associated with these structures should be large enough to convey debris through the crossing. However, debris may become lodged along the fence located immediately downstream of the crossing (See Appendix B – Photographs: Mill Creek Photographs) causing a potential increase in tailwater and ultimately an increase in headwater elevations.



SUB-AGENCY DITCH:

The Sub-Agency Ditch is a reasonably straight irrigation channel with a slope of 0.0527 percent. Currently, a single span timber bridge measuring approximately 6 meters (20 feet) in length spans the ditch at the proposed crossing (*See Appendix B – Photographs: Sub-Agency Photographs*). Tribal Officials are interested in replacing the Timber Bridge with a RCBC. The following information was used for developing a hydraulic analysis.

- Slope through the proposed RCBC is 0.000527 m/m (ft/ft).
- Top of grade elevation at crossing is estimated to be 1563.16 meters (5129.86 feet).
- Assume 0.40 meters (1.31 feet) of Roadway Surfacing Depth.
- Assume 0.610 meters (2.00 feet) of cover.
- Maximum Culvert Height is estimated to be 1.98 meters (6.5 feet).
- Flowlne elevation through the proposed RCBC is 1560.01 meters (5118.13 feet).

Combining the above information with surveyed cross sections, a hydraulic analysis was completed. Analysis was performed using the computer program CDS (Culvert Design System). Table 4 summarizes the proposed RCBC alternatives for the proposed Mill Creek Crossing.

Table 4 - SUB-AGENCY DITCH PROPOSED STRUCTURE HYDRAULICS

STRUCTURE mm x mm (ft) x (ft)	HW _{WR} DEPTH m / (ft)	V _{WR} OUTLET m/s / (ft/s)	OUT _{WR} DEPTH m / (ft)	HW _{2(WR)} DEPTH m / (ft)	V _{2(WR)} OUTLET m/s / (ft/s)	Q _{2(WR)} OVERFLOW m ³ /s / (ft ³ /s)
1 – 1220 x 1220 1 – 4.0 x 4.0	2.04 (6.70)	2.68 (8.80)	1.22 (4.00)	2.65 (8.70)	2.87 (9.40)	3.70 (130.60)
1 – 3600 x 1800 1 – 12.0 x 6.0	1.43 (4.70)	0.76 (2.50)	1.40 (4.60)	2.01 (6.60)	1.19 (3.90)	0.00 (0.00)
1 – 3000 x 1800 1 – 10.0 x 6.0	1.46 (4.80)	0.91 (3.00)	1.40 (4.60)	2.07 (6.80)	1.43 (4.70)	0.00 (0.00)
1 – 2700 x 1800 1 – 9.0 x 6.0	1.49 (4.90)	1.04 (3.40)	1.40 (4.60)	2.10 (6.90)	1.58 (5.20)	0.00 (0.00)

Q_{WR}: Water Right provided by the State Engineers Office.

Q_{2(WR)}: 2 times the Water Right as per Irrigation District.

Alternative 1 in Table 4 shows 1 – 1220 mm (4.0 ft) x 1220 mm (4.0 ft). This alternative was developed from the design option in CDS and meets the hydraulic parameters for this site, mainly an allowable headwater depth of 2.29 meters (7.50 feet) and a culvert height not to exceed 1.98 meters (6.50 feet). However, velocities for this alternative are very high and would most likely scour this irrigation ditch. WYDOT Operating Policy 18-6 suggests that the proposed structure should accommodate the current water right without an increase in the velocity beyond what the irrigation ditch material can withstand. Velocities in excess of 8.0 feet



per second will most likely cause erosion and local scour problems to the canal.

Alternatives two through four reflect structures, which were hydraulically reviewed in CDS. Two criteria standards were applied in these alternatives. First, velocities should be minimized to prevent scour. Secondly, the difference in headwater and tailwater elevations should be minimized in order to prevent impedance through the proposed RCBC. Velocities associated with these alternatives are low enough to minimize any scour or erosion problems to this crossing. Headwater is contained within the existing canal banks and shows no indication that headwaters would develop to a level where overtopping would occur to the canal banks.

IV. EROSION CONTROL

MILL CREEK:

Velocities through the proposed Mill Creek RCBC could cause erosion to the existing creek bed material. Placement of riprap material upstream and downstream of the selected structure is recommended to protect the creek and structure from scour and erosion. Preliminary riprap size was estimated using the computer program, Riprap Design System, by West Consultants, Incorporated. Using an average velocity of 3.74 meters per second (12.30 feet per second), average downstream flow depth of 4.50 feet along with a safety factor of 1.1, rip-rap size was calculated using the HEC-11 Method. Table 5 summarizes estimated riprap sizes.

Table 5 – PRELIMINARY RIPRAP

% SMALLER BY SIZE	ROCK SIZE m (ft)	ROCK SIZE lbs
D ₁₀₀	0.69 (2.25)	1000
D ₅₀	0.55 (1.80)	500
D ₁₀	0.29 (0.95)	75

Values in Table 5 are estimations and will need to be refined upon the structure selection recommendation.

Velocities through the Sub-Agency Ditch are minimal and are not estimated to cause scour or erosion to the crossing.

V. PERMITS

MILL CREEK:

A Corps of Engineers Permit will be needed for structure replacement at Mill Creek. A Pre-Construction Notification (PCN) for Nationwide Permit 14 should be submitted to the Wyoming Corps of Engineers Office. Of interest in the PCN is what type of replacement will take place and are wetlands affected by proposed construction activity. If wetlands are affected by



proposed construction, the Corps of Engineers will request the impacted area be delineated before a permit is approved.

SUB-AGENCY DITCH:

A Corps of Engineers Permit may be needed for the Sub-Agency Ditch. A separate permit may also need to be filed with the Shoshone and Arapaho Tribes Office of the Tribal Water Engineer for structure replacement.

VI. GAME AND FISH

Since the proposed Mill Creek Crossing is on the Wind River Indian Reservation, the Wyoming Game and Fish Department has not classified this crossing in terms of fishery status. Therefore, construction at this crossing will not be limited to trout fishery restrictions.

VII. CONCLUSION

The proposed structures summarized in this report for Mill Creek and the Sub-Agency Ditch will convey estimated flowrates while meeting WYDOT Drainage Criteria. Information used for analysis is based on plan and profile sheets provided by APEX Surveying. Any design modifications, which could affect gradeline elevations over these crossings, should be scrutinized to insure adjustments do not change the hydraulics of these sites.

VIII. REFERENCES

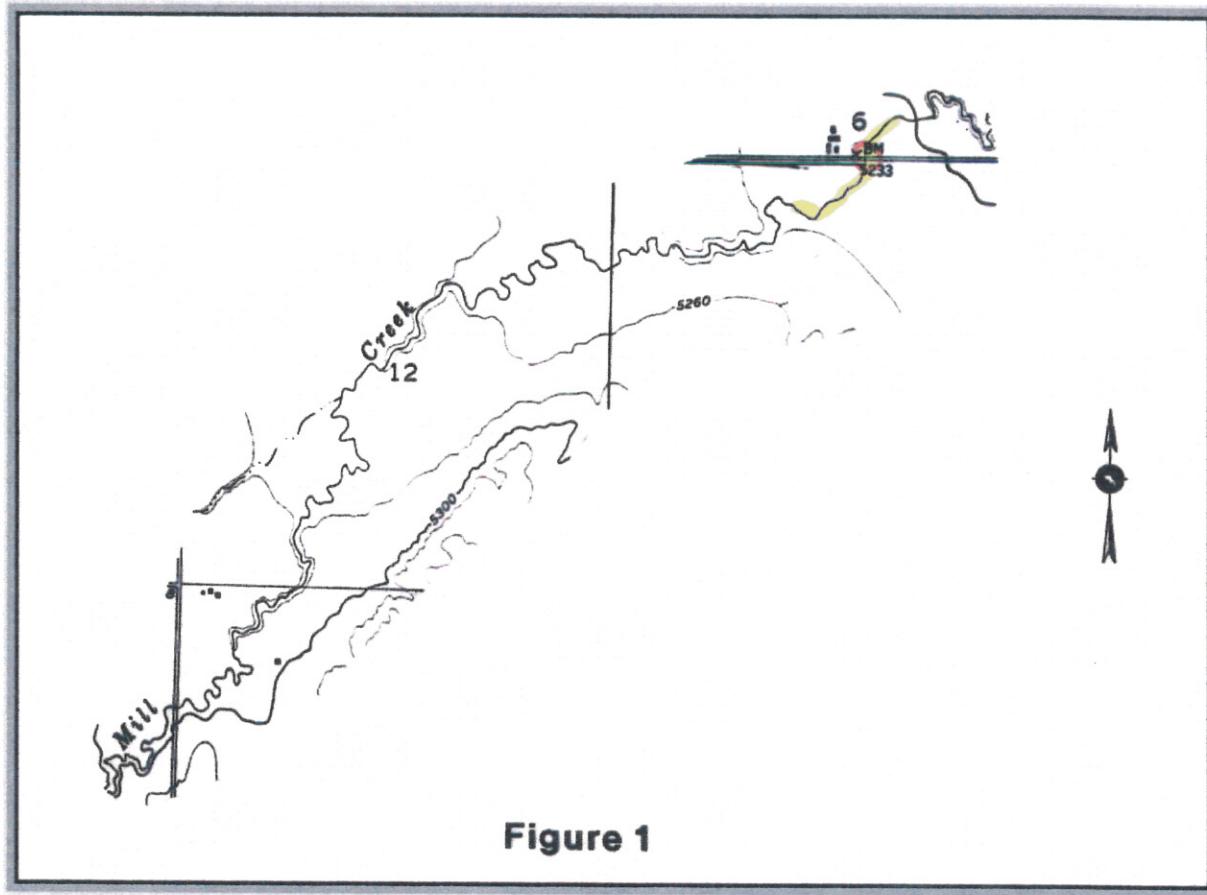
1. Streamflows In Wyoming, USGS Water Resources Investigations Report 80-4045, 1998.
2. Chow, Ven Te, Open Channel Hydraulics, McGraw-Hill Book Company, Inc., New York, 1959.
3. HEC-RAS River Analysis System Hydraulic Reference Manual, United States Army Corps of Engineers, 1997.
4. Rosgen, Dave, Applied River Morphology, Wildland Hydrology, Pagosa Springs, Colorado, 1996.



APPENDIX A
SITE & VICINITY MAPS



MILL CREEK
FREMONT COUNTY



SITE & VICINITY MAP:

*Section 7
Township 1 S
Range 2 E*

NOT TO SCALE

SUB-AGENCY DITCH
FREMONT COUNTY

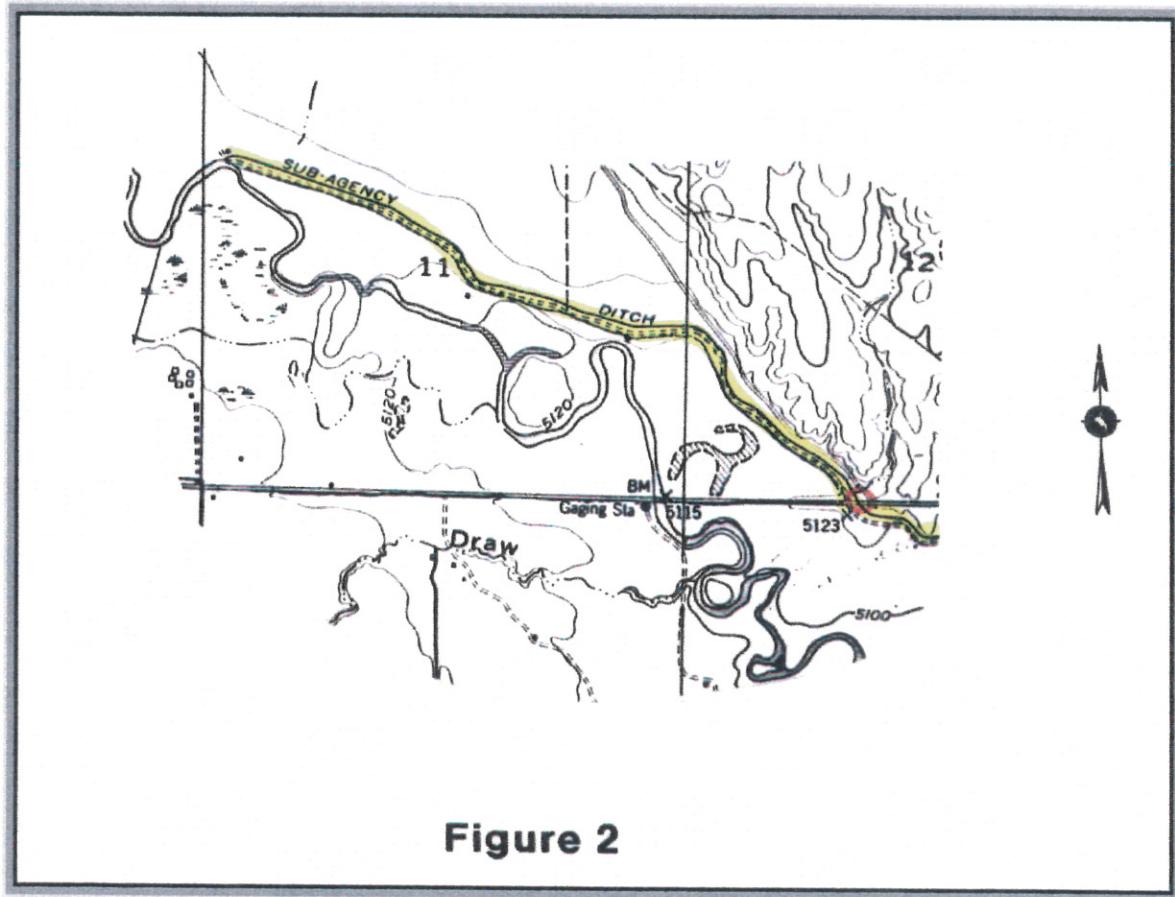


Figure 2

SITE & VICINITY MAP:

*Section 12
Township 1 S
Range 2 E*

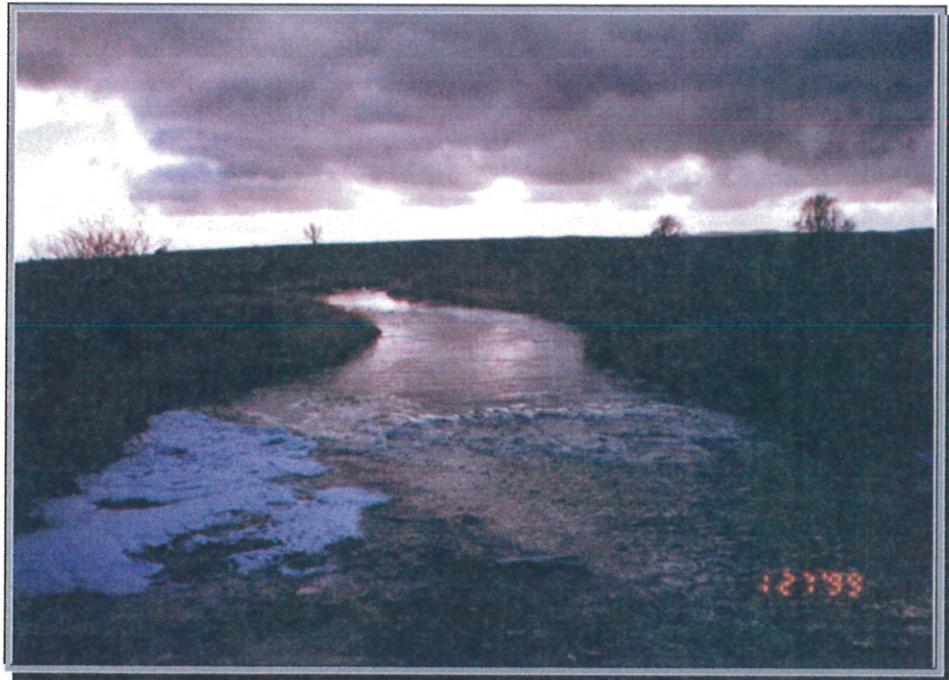
NOT TO SCALE

APPENDIX B
PHOTOGRAPHS



MILL CREEK
PHOTOGRAPHS





MILL CREEK: LOOKING UPSTREAM FROM PIPE INLET



MILL CREEK: LOOKING AT PIPE INLET



MILL CREEK: LOOKING AT PIPE OUTLET



MILL CREEK: LOOKING DOWNSTREAM FROM PIPE OUTLET

SUB-AGENCY DITCH
PHOTOGRAPHS





SUB AGENCY DITCH: LOOKING UPSTREAM TOWARDS BRIDGE



SUB AGENCY DITCH: LOOKING DOWNSTREAM FROM BRIDGE



SUB AGENCY DITCH: LOOKING DOWNSTREAM TOWARDS BRIDGE



SUB AGENCY DITCH: LOOKING UPSTREAM FROM BRIDGE

APPENDIX C
HYDROLOGY

MK CENTENNIAL

CENTENNIAL ENGINEERING, INC.



MILL CREEK
HYDROLOGY

MK CENTENNIAL
CENTENNIAL ENGINEERING, INC.





Map of region surrounding Mill Cr Ab Ray Lake Outlet Canal, Nr Ft Washakie



Station Information

Station Number	Latitude (ddmmss)	Longitude (ddmmss)	County	Basin Name	Drainage Area (miles ²)	Datum (ft above NGVD)
06230190	425650	1084829	Fremont	Little Wind	15.8	5505

```

# US GEOLOGICAL SURVEY
# PEAK FLOW DATA
#
# Station name : Mill Cr Ab Ray Lake Outlet Canal, Nr Ft Washakie
# Station number: 06230190
# latitude (ddmmss)..... 425650
# longitude (ddmmss)..... 1084829
# state code..... 56
# county..... Fremont
# hydrologic unit code..... 10080002
# basin name..... Little Wind
# drainage area (square miles)..... 15.8
# contributing drainage area (square miles).....
# gage datum (feet above NGVD)..... 5505
# base discharge (cubic ft/sec).....
# Gage heights are given in feet above gage datum elevation.
# Discharge is listed in the table in cubic feet per second.
#
# Peak flow data were retrieved from the
# National Water Data Storage and Retrieval System (WATSTORE).
#
# Format of table is as follows.
# Lines starting with the # character are comment lines describing the data
# included in this file. The next line is a row of tab-delimited column
# names. The next line is a row of tab-delimited data type codes that
# describe the width and type of data in each column. All following lines
# are rows of tab-delimited data values.
#
# ----Water Years Retrieved---
# 1990 - 1996

```

Type	Station	Date	Discharge	DisQual	GageAtPeak	GageQual	HighSince
1s	15s	10d	6n 12s	8n	4s	2s	10d 6n
3	06230190		08/02/1990	33.0		2.30	
3	06230190		06/03/1991	426	5	4.20	
3	06230190		06/24/1992	37.0	5	2.12	
3	06230190		06/03/1993	132	5	3.03	
3	06230190		06/22/1994	21.0	5	1.79	
3	06230190		06/16/1995	210	5	3.52	
3	06230190		05/25/1996	28.0	5	2.05	

PROJECT: 17-MILE ROAD
SUBJECT: Mill Creek
ITEM: Drainage Area

CLIENT: Wyoming Department of Transportation
MADE BY: RCM CHECKED BY:
DATE: 1/15/99

Quad: Lander, Lander NW, Ray Lake
County: Fremont
State: Wyoming

Planimeter Reading: 6787

Measuring Constant:

$$C_A = \frac{Sc^c(u)}{43560}$$

Note: Equation from Instruction Manual for
LASICO Mechanical Polar Planimeter.

C_A: Measuring Constant
Sc: Scale Ratio
u: Value of One Planimeter

Note: From LASICO Instruction Manual:
Note: Map Scale is 1 inch = 6333.33 feet:
u = 0.01 in²
Sc = 2000

$$C_A = 0.918 \text{ Acres}$$

Drainage Area:

$$\text{Drainage Area} = C_A(\text{Planimeter Reading})$$

Drainage Area =	6232.32 Acres	Use	6232 Acres
	9.74 Miles ²	Use	9.7 Miles ²

NOTE: USGS GAGE SITE 08230100 MILL CREEK ABOVE RAY LAKE OUTLET CANAL NEAR RT. 14 WASHAKIE MOUNTAINS DRRAINAGE AREA OF 6232.32 ACRES OR 9.74 MILES² IN SIZE. THIS IS THE TOTAL DRAINAGE AREA FOR THE MILL CREEK CATCHMENT AREA. THE DRAINAGE AREA IS LOCATED IN THE STATE OF WYOMING, COUNTY OF FREMONT, AND THE QUADRANGLE IS LANDER, Lander NW, Ray Lake.

Total Drainage Area = 6232.32 Acres or 9.74 Miles² for total Drainage Area 08230100

Mill Creek Hydrology

WYOMING USGS REGIONAL HYDROLOGY STUDY

HYDROLOGIC REGION # 1

Drainage area (sq mi) 25.50
Precipitation index 12

FREQUENCY (yr)	DISCHARGE (cfs)	VOLUME	VOLUME
		1 (ac-ft)	2 (ac-ft)
2.	115.	90.	12.
5.	210.	182.	29.
10.	290.	262.	46.
25.	420.	380.	74.
50.	535.	483.	100.
100.	660.	597.	130.
500.	1030.	919.	220.

Mean Annual Flow (Qa) = 9.231 cfs

Bank full discharge at 1.5 year frequency 69.90 cfs
Volume not computed for mountainous region

Mill Creek Hydrology

WYOMING USGS REGIONAL HYDROLOGY STUDY

HYDROLOGIC REGION # 2

Drainage area (sq mi) 25.50
Geographic Factor 1
Precipitation index 12

FREQUENCY (yr)	DISCHARGE (cfs)	VOLUME	VOLUME
		1 (ac-ft)	2 (ac-ft)
2.	165.	90.	12.
5.	410.	182.	29.
10.	650.	262.	46.
25.	1050.	380.	74.
50.	1410.	483.	100.
100.	1830.	597.	130.
500.	3070.	919.	220.

Mean Annual Flow (Qa) = 0.699 cfs

Bank full discharge at 1.5 year frequency 92.12 cfs

Volume 1 is computed using basin characteristics (drainage area etc.)

Volume 2 is computed using peak discharge

Sheet _____

Job No. _____

Project 17-Mile Client WYDOT
Subject Hydrology Made By Rob Date 10-7-99
Item Mill Creek

P_{25} Weighted Average between Mountainous and High Desert Regions.

$$P_{25} = 585 \left(\frac{1.82}{25.5} \right) + 1050 \left(\frac{23.68}{25.5} \right)$$

$$P_{25} = 1013.24 \Rightarrow 1015 \text{ cfs}$$

P_{100} Weighted Average between Mountainous and High Desert Regions.

$$P_{100} = 660 \left(\frac{1.82}{25.5} \right) + 1830 \left(\frac{23.68}{25.5} \right)$$

$$P_{100} = 1716.50 \text{ cfs}$$

SUB-AGENCY DITCH

HYDROLOGY

MK CENTENNIAL

CENTENNIAL ENGINEERING, INC.





State Engineer's Office

Herschler Building, 4-E Cheyenne, Wyoming 82002
(307) 777-7354 FAX (307) 777-5451
seoleg@missc.state.wy.us

JIM GERINGER
GOVERNOR

GORDON W. FASSETT
STATE ENGINEER

COPY

January 26, 1999

RECORDED
JAN 29 1998
FBI - DENVER

Mr. Robert C. Moore
MK Centennial
5920 Yellowstone Road, Suite 1
Cheyenne, WY 82009

RE: Request for Ditch Capacity - 17 Mile Road

Dear Mr. Moore:

Please excuse my delay in responding to your request. A concentrated effort was made to review all records within our office that could provide the information that you requested.

As I understand your request, your company is drafting plans for a Highway Department Project. This project includes portions of 17 Mile Road that pass over some ditches. Ditch capacity information is needed so that plans can be made to adequately provide structures for the ditches that would also protect the road.

This office can give information for all state water rights but may not have information on private ditches within the Wind River Indian Reservation. The records from this office revealed that two state water right ditches cross under 17 Mile Road. No state water right information could be found on the other ditches involved in this Highway Department Project. There could be several reasons for that. The ditches could be laterals or extensions of state water right ditches and to find that state water right permit, we would need the headgate location of the ditch or the point of use for that state water right permit. Another reason why this office has no information on the ditches could be that the ditches are private ditches within the Reservation. Very little information exists for those private ditches other than what has been awarded by the Court for Reserved Right Awards.

The Reserved Right Awards started out as claims by the tribes within the Wind River Indian Reservation. After review by the District Court of these claims, the Court awarded Reserved Right Awards to the tribes for water rights with an 1868 priority date. Both the state water rights mentioned below also have Reserved Right Awards attached to the ditches.

Mr. Robert Moore
January 26, 1999
Page Two

Each of the ditches involved with this Highway Department Project were closely scrutinized starting out with obtaining the full course of the ditch and probable sources of water from a 7 1/2 minute USGS Quadrangle map. Where the ditch begins and ends is questionable. However, by determining the full course of the ditch, it is more likely that all ditch information will be found. Records that were used for this search included the following:

- a. Headgate or aka Township Cards - this record lists headgate locations for ditches, permit number, name of ditch, and source within each township and range.
- b. Stream Sequence Cards - this record lists source and tributary sequence, permit number, name of ditch, and headgate location within each tributary.
- c. Stream Name Cards - this record lists the tributary sequence for each source.
- d. Linen Plat Book - this record shows adjudicated state water rights but also has a page for each township and range where the adjudicated ditches are drafted (if a ditch is unadjudicated, it would not be shown).
- e. Tabulation of Adjudicated Water Rights - this record shows adjudicated water rights listed by source and tributary sequence, permit number, name of ditch, headgate location and amount of adjudication.
- f. Safety of Dam Records - these records show plans and specifications for construction on diversion dams or diversion systems. The state water right permits 6582 and 6632 would fall under the Safety of Dam regulations because the carrying capacity of the ditch is in excess of 50cfs. However, no records were shown for these ditches.

Note: Adjudicated Water Rights are water rights that have been completed to the final stage of adjudication which makes it a valid water right.

A. Hansen Drain Extension
Intersects 17 Mile Road at section line common to Sections 1 and 12, T.1S., R.1E. Begins Sec. 15, T.1S., R.1E., continues through Sections 1, 11, 12 and 14, T.1S., R.1E., turns into Hansen Drain in Section 1, T.1S., R.1E., and ends in Section 6, T.1S., R.2E, now becomes part of Mill Creek Drain then dumps into Little Wind River.

A. Search revealed - No information available for state water right or private ditch.

Mr. Robert Moore
January 26, 1999
Page Four

G. Search revealed - No information available for state water right or private ditch.

H. Sub Agency Ditch

Intersects 17 Mile Road at bottom of Section 12, T.1S., R.2E., section line common to Sections 15 and 16, T.1S., R.3E. and bottom of Section 10, T.1S., R.3E. Begins in Section 11, T.1S., R.2E. and runs through Sections 11, 12 and 13, T.1S., R.2E., Sections 10, 11, 12, and 15-18, T.1S., R.3E. and Sections 7, 8, 17 and 18, T.1S., R.4E. Ends in Section 17, T.1S., R.4E. at Little Wind River.

H. Search revealed - PERMIT 6582, NEW SUBAGENCY DITCH - 140.74CFS

If you have any questions or need any further assistance, please call me at 777-6002.

Sincerely,

Debbie Hallberg
Debbie Hallberg
Water Right Analyst
Special Projects

APPENDIX D

HYDRAULICS

MK CENTENNIAL

CENTENNIAL ENGINEERING, INC.



MILL CREEK

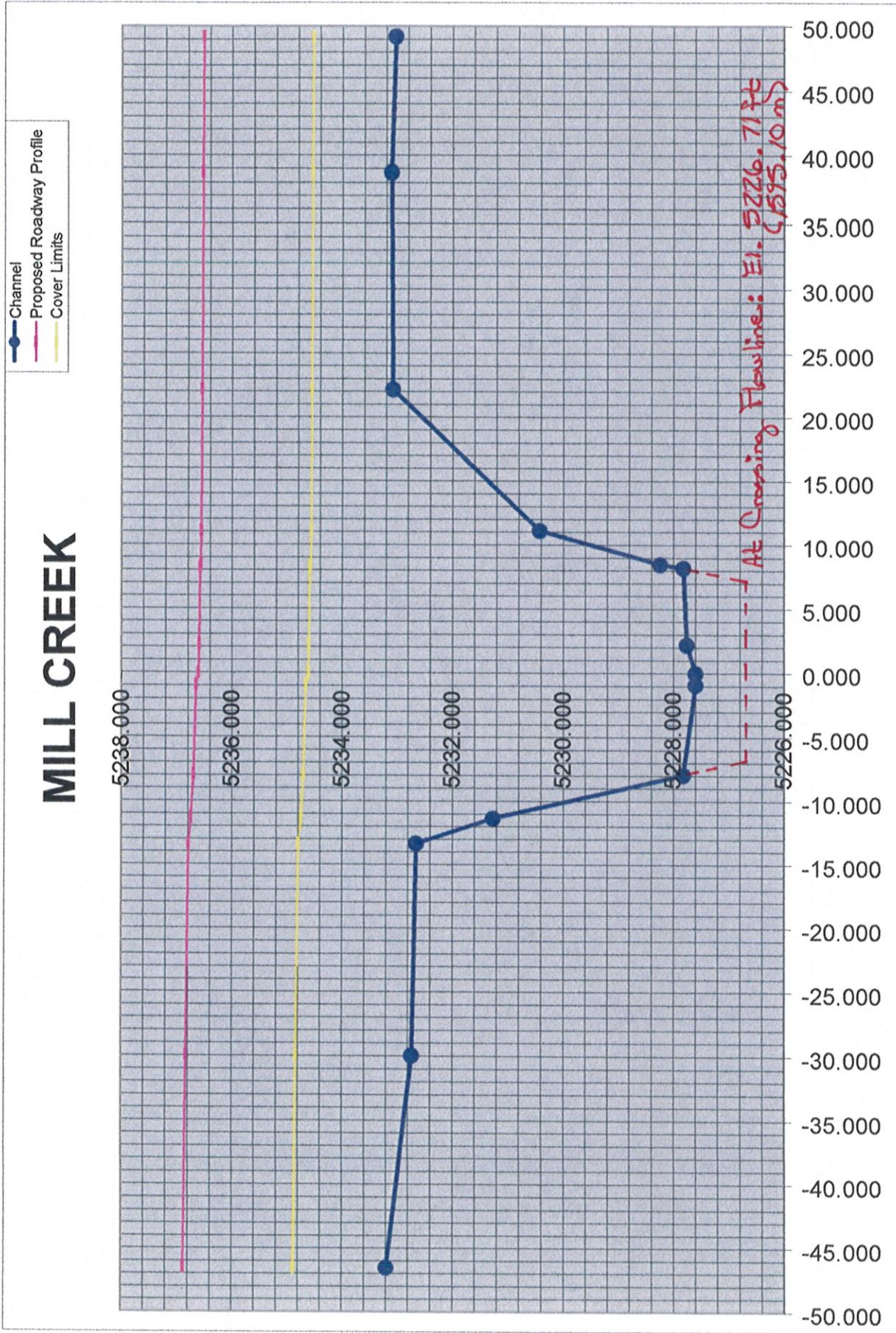
HYDRAULICS

MK CENTENNIAL

CENTENNIAL ENGINEERING, INC.



MILL CREEK



MILL CREEK

PROJECT: 17-Mile Road
SUBJECT: Mill Creek Culvert Information
ITEM: Culvert Elevations

CLIENT: Wyoming Department of Transportation
MADE BY: RCM
DATE: 1/18/99

Culvert Profile

Elevation	Distance	Channel Slope:	Upstream Slope:
0	1593.32		
20	1593.29		
40	1593.1	-0.0043715	
60	1592.97		-0.0055
80	1592.86		
100	1592.91		
108.677	1592.9		

Culvert Information

Estimated Top of Grade Elevation:

1596.00 meters
5236.22 feet

Estimated Culvert Inlet Flowline Elevation:

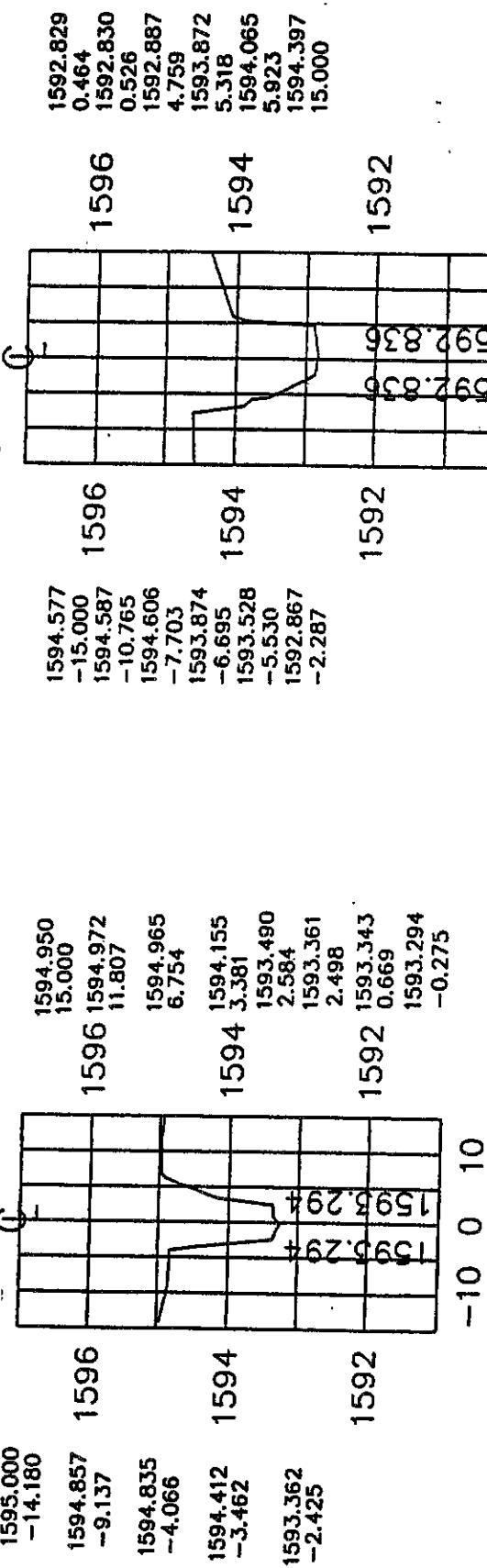
1593.10 meters
5226.71 feet

Estimated Culvert Outlet Flowline Elevation:

1593.01 meters
5226.41 feet

BOX CULVERT STA. 6+604

0+020
CREEK



millcrk.txt

JOB Culvert Analysis: Mill Creek: Project: 17-Mile Road
PRT 1 1 1 3
SI 1 1
* *****
* ***** Downstream Cross Section for Tailwater Conditions *****
* *****
XS -153 0 0.00437
GR -50.00 5250.00 -49.21 5231.55 -35.32 5231.65 -25.27 5231.65
GR -21.97 5229.25 -18.14 5228.11 -7.50 5225.94 0.00 5225.84
GR 1.52 5225.82 1.73 5225.82 15.61 5226.01 17.45 5229.24
GR 19.43 5229.87 49.21 5230.96 50.00 5250.00
SA -35.32 19.43
N 0.045 0.035 0.045
* *****
* ***** Upstream Cross Section for Storage Conditions *****
* *****
XS 118
GR -50.00 5240.00
GR -46.52 5232.94 -29.98 5232.47 -13.34 5232.40
GR -11.36 5231.01 -7.96 5227.57 -0.90 5227.34
GR 0.00 5227.34 2.19 5227.50 8.20 5227.56
GR 8.48 5227.99 11.09 5230.17 22.16 5232.82
GR 38.74 5232.85 49.21 5232.78 50.00 5240.00
USL 0.0055
* *****
* ***** Road Cross Section Profile *****
* *****
XR 0.00 60 1
GR -46.525 5236.88 0.00 5236.51 49.215 5236.22
* *****
* Culvert Geometry
STA 6604
SL 0.00437 100 5226.87 0 9.35
* Hydrologic Analysis
HD 9.0 6.0
RCB 11
CMP 51
RCP 11
ECP 11
RPD 25 100
Q 1015 1747
V 188 351
SCR 31
RUN
HR 2 8 6
RCB 11
RPD 25 100
RUN
HR 3 5 6
RCB 11
RUN
HR 3 6 6
RCB 11
RUN
HR 1 9.33 6.25
MPA 83
RUN
HR 1 12 7
RCB 11
RUN
END

```
*****
*****
**
**      CCCCCCCCCC      DDDDDDDDD      SSSSSSSSS      **
**      CCCCCCCCCCCC      DDDDDDDDDDD      SSSSSSSSSSS      **
**      CC      CC      DD      DD      SS      SS      **
**      CC      DD      DD      SS      **
**      CC      DD      DD      SSS      **
**      CC      DD      DD      SSSSSSSS      **
**      CC      CULVERT      DD      DD      DESIGN      SSSSSSSSS SYSTEM      **
**      CC      DD      DD      SSS      **
**      CC      DD      DD      SS      **
**      CC      CC      DD      DD      SS      SS      **
**      CCCCCCCCCCCC      DDDDDDDDDDD      SSSSSSSSSSS      **
**      CCCCCCCCCCCC      DDDDDDDDD      SSSSSSSSS      **
*****
```

METRIC <> ENGLISH VERSION
VERSION 6.1 LEVEL 0 RELEASE DATE 08/98

Culvert Analysis: Mill Creek: Project: 17-Mile Road
CULVERT DESIGN SYSTEM
Culvert Analysis: Mill Creek: Project: 17-Mile Road

Time 10: 1:42
Date 10/ 7/1999
FILE NAME C:\CDS\MILLC

CHANNEL STAGE DISCHARGE RELATIONSHIP

CHANNEL SLOPE = .00437FT/FT
STAGE DISCHARGE INPUT VERIFICATION

VERIFIED?

INPUT

CHECKER_____

DESIGNER_____

X(1) = -50.0	Y(1) = 5250.0	MANNINGS NUMBER = .045
X(2) = -49.2	Y(2) = 5231.5	MANNINGS NUMBER = .045
X(3) = -35.3	Y(3) = 5231.6	MANNINGS NUMBER = .045
X(4) = -25.3	Y(4) = 5231.6	MANNINGS NUMBER = .035
X(5) = -22.0	Y(5) = 5229.3	MANNINGS NUMBER = .035
X(6) = -18.1	Y(6) = 5228.1	MANNINGS NUMBER = .035
X(7) = -7.5	Y(7) = 5225.9	MANNINGS NUMBER = .035
X(8) = .0	Y(8) = 5225.8	MANNINGS NUMBER = .035
X(9) = 1.5	Y(9) = 5225.8	MANNINGS NUMBER = .035
X(10) = 1.7	Y(10) = 5225.8	MANNINGS NUMBER = .035
X(11) = 15.6	Y(11) = 5226.0	MANNINGS NUMBER = .035
X(12) = 17.4	Y(12) = 5229.2	MANNINGS NUMBER = .035
X(13) = 19.4	Y(13) = 5229.9	MANNINGS NUMBER = .035
X(14) = 49.2	Y(14) = 5231.0	MANNINGS NUMBER = .045
X(15) = 50.0	Y(15) = 5250.0	MANNINGS NUMBER = .045

CULVERT DESIGN SYSTEM
 CHANNEL STAGE DISCHARGE RELATIONSHIP
 CHANNEL SLOPE = .00437FT/FT
 STAGE DISCHARGE INPUT VERIFICATION

INPUT VERIFIED?
 DESIGNER_____

CHECKER_____

X-SECTION NOT PROPERLY SUBDIVIDED GEOMETRICALLY: STAGE DISCHARGE CURVE HAS BEEN SMOOTHED FOR
 1 POINTS AT ELEVATION 5231.64

ELEVATION feet	DEPTH feet	DISCHARGE cfs	VELOCITY fps	MAX. VELOCITY fps
5225.81	.00	.00	.00	.00
5225.82	.01	.00	.08	.08
5225.84	.03	.01	.16	.21
5225.94	.13	.51	.45	.64
5226.01	.20	1.70	.65	.86
5226.31	.50	14.83	1.50	1.71
5226.61	.80	37.20	2.11	2.31
5226.91	1.10	67.50	2.60	2.83
5227.21	1.40	105.20	3.03	3.29
5227.51	1.70	150.07	3.42	3.70
5227.81	2.00	202.00	3.76	4.09
5228.11	2.30	261.27	4.09	4.45
5228.41	2.60	329.42	4.42	4.83
5228.71	2.90	404.46	4.73	5.18
5229.01	3.20	486.35	5.02	5.51
5229.24	3.43	554.08	5.23	5.76
5229.25	3.44	556.85	5.24	5.76
5229.55	3.74	650.27	5.49	6.06
5229.87	4.06	757.79	5.76	6.37
5230.17	4.36	877.92	6.03	6.74
5230.47	4.66	1008.42	6.22	7.09
5230.96	5.15	1249.19	6.41	7.63
5231.26	5.45	1418.80	6.54	7.95
5231.55	5.74	1595.41	6.69	8.26
5231.64	5.83	1652.95	6.73	8.35
5231.65	5.84	1677.62	6.80	8.45
5231.95	6.14	1702.28	6.17	7.90
5232.25	6.44	1950.05	6.38	8.34
5232.55	6.74	2214.57	6.61	8.75
5232.85	7.04	2494.80	6.84	9.14
5233.15	7.34	2789.93	7.08	9.50
5233.45	7.64	3099.30	7.31	9.85
5233.75	7.94	3422.34	7.55	10.18
5234.05	8.24	3758.54	7.78	10.49
5234.35	8.54	4107.48	8.01	10.79
5234.65	8.84	4468.75	8.24	11.08
5234.95	9.14	4841.99	8.47	11.36
5235.25	9.44	5226.88	8.69	11.64
5235.55	9.74	5623.11	8.91	11.90
5235.85	10.04	6030.41	9.13	12.16
5236.15	10.34	6448.52	9.34	12.41
5236.45	10.64	6877.19	9.55	12.65
5236.75	10.94	7316.20	9.76	12.89
5237.05	11.24	7765.35	9.97	13.12
5237.35	11.54	8224.43	10.17	13.35

ELEVATION feet	DEPTH feet	DISCHARGE cfs	VELOCITY fps	MAX. VELOCITY fps
5237.65	11.84	8693.26	10.37	13.58
5237.95	12.14	9171.66	10.57	13.80
5238.25	12.44	9659.46	10.76	14.02
5238.55	12.74	10156.51	10.95	14.23
5238.85	13.04	10662.65	11.14	14.44
5239.15	13.33	11177.75	11.33	14.65
5239.44	13.63	11701.67	11.51	14.85
5239.74	13.93	12234.27	11.69	15.05
5240.04	14.23	12775.44	11.87	15.25
5240.34	14.53	13325.06	12.05	15.44
5240.64	14.83	13883.01	12.23	15.64
5240.94	15.13	14449.19	12.40	15.83
5241.24	15.43	15023.49	12.57	16.02
5241.54	15.73	15605.82	12.74	16.20
5241.84	16.03	16196.06	12.91	16.39
5242.14	16.33	16794.14	13.08	16.57
5242.44	16.63	17399.97	13.24	16.75
5242.74	16.93	18013.45	13.40	16.92
5243.04	17.23	18634.52	13.57	17.10
5243.34	17.53	19263.08	13.72	17.28
5243.64	17.83	19899.05	13.88	17.45
5243.94	18.13	20542.38	14.04	17.62
5244.24	18.43	21192.98	14.20	17.79
5244.54	18.73	21850.78	14.35	17.96
5244.84	19.03	22515.72	14.50	18.12
5245.14	19.33	23187.73	14.65	18.29
5245.44	19.63	23866.75	14.80	18.45
5245.74	19.93	24552.72	14.95	18.61
5246.04	20.23	25245.57	15.10	18.77
5246.34	20.53	25945.25	15.24	18.93
5246.64	20.83	26651.72	15.39	19.09
5246.94	21.13	27364.89	15.53	19.25
5247.24	21.43	28084.73	15.67	19.41
5247.54	21.73	28811.19	15.82	19.56
5247.84	22.03	29544.22	15.96	19.71
5248.14	22.33	30283.75	16.10	19.87
5248.44	22.63	31029.76	16.23	20.02
5248.74	22.93	31782.20	16.37	20.17
5249.04	23.23	32540.99	16.51	20.32
5249.34	23.53	33306.14	16.64	20.47
5249.64	23.83	34077.56	16.78	20.61
5250.00	24.19	35016.86	16.94	20.79

CULVERT DESIGN SYSTEM

STAGE STORAGE

UPSTREAM SLOPE = .00550 FEET/FOOT

CROSS SECTION STATION = .00

X (DISTANCE-feet)	Y (ELEVATION-feet)
-50.00	5240.00
-46.52	5232.94
-29.98	5232.47
-13.34	5232.40
-11.36	5231.01
-7.96	5227.57
-.90	5227.34
.00	5227.34
2.19	5227.50
8.20	5227.56
8.48	5227.99
11.09	5230.17
22.16	5232.82
38.74	5232.85
49.21	5232.78
50.00	5240.00

CROSS SECTION STATION = 118.00

X (DISTANCE-feet)	Y (ELEVATION-feet)
-50.00	5240.00
-46.52	5232.94
-29.98	5232.47
-13.34	5232.40
-11.36	5231.01
-7.96	5227.57
-.90	5227.34
.00	5227.34
2.19	5227.50
8.20	5227.56
8.48	5227.99
11.09	5230.17
22.16	5232.82
38.74	5232.85
49.21	5232.78
50.00	5240.00

CULVERT DESIGN SYSTEM

STAGE STORAGE

COMPUTATIONAL RESULTS

DEPTH feet	STORAGE acre-ft	AREA INUNDATED acres
.00	.00	.00
.13	.00	.02
.25	.01	.05
.38	.01	.06
.51	.02	.06
.63	.03	.07
.76	.04	.07
.89	.05	.08
1.01	.06	.08
1.14	.07	.09
1.26	.09	.10
1.39	.10	.10
1.52	.11	.11
1.64	.13	.12
1.77	.15	.12
1.90	.17	.13
2.02	.19	.14
2.15	.21	.14
2.28	.23	.15
2.40	.25	.16
2.53	.27	.17
2.66	.30	.18
2.78	.32	.18
2.91	.35	.19
3.04	.38	.20
3.16	.41	.22
3.29	.44	.23
3.41	.48	.24
3.54	.51	.25
3.67	.55	.27
3.79	.59	.28
3.92	.63	.30
4.05	.67	.31
4.17	.71	.33
4.30	.76	.34
4.43	.81	.36
4.55	.86	.38
4.68	.91	.39
4.81	.97	.41
4.93	1.03	.43
5.06	1.09	.45
5.19	1.16	.71
5.31	1.25	.79
5.44	1.35	.88
5.56	1.48	1.35
5.69	1.63	1.40
5.82	1.79	1.42

CULVERT DESIGN SYSTEM

STAGE STORAGE

COMPUTATIONAL RESULTS

DEPTH feet	STORAGE acre-ft	AREA INUNDATED acres
5.94	1.96	1.45
6.07	2.12	1.48
6.20	2.29	1.50
6.32	2.47	1.53
6.45	2.65	1.56
6.58	2.83	1.58
6.70	3.02	1.61
6.83	3.21	1.64
6.96	3.41	1.66
7.08	3.61	1.69
7.21	3.82	1.72
7.33	4.03	1.74
7.46	4.25	1.77
7.59	4.47	1.80
7.71	4.69	1.82
7.84	4.92	1.85
7.97	5.15	1.88
8.09	5.39	1.91
8.22	5.63	1.93
8.35	5.88	1.96
8.47	6.13	1.99
8.60	6.38	2.01
8.73	6.64	2.04
8.85	6.91	2.07
8.98	7.18	2.10
9.11	7.45	2.12
9.23	7.73	2.15
9.36	8.01	2.18
9.48	8.30	2.21
9.61	8.59	2.23
9.74	8.88	2.26
9.86	9.18	2.29
9.99	9.49	2.32
10.12	9.80	2.35
10.24	10.11	2.37
10.37	10.43	2.40
10.50	10.75	2.43
10.62	11.08	2.46
10.75	11.41	2.49
10.88	11.75	2.51
11.00	12.09	2.54
11.13	12.44	2.57
11.26	12.79	2.60
11.38	13.14	2.63
11.51	13.50	2.65
11.63	13.87	2.68
11.76	14.24	2.71

CULVERT DESIGN SYSTEM

STAGE STORAGE

COMPUTATIONAL RESULTS

DEPTH feet	STORAGE acre-ft	AREA INUNDATED acres
11.89	14.61	2.74
12.01	14.99	2.77
12.14	15.37	2.80
12.27	15.76	2.82
12.39	16.15	2.85
12.52	16.55	2.88

Warning: STORAGE TABLE EXTRAPOLATED FOR HEADWATER DEPTHS EXCEEDING
12.520020 feet

Extending cross sections recommended if headwater depths exceed table for more
accurate results

CULVERT DESIGN SYSTEM

Culvert Analysis: Mill Creek: Project: 17-Mile Road

ROADWAY PROFILE COORDINATES	
STATION feet	ELEVATION feet
-46.5	5236.9
.0	5236.5
49.2	5236.2

ROADWAY ENDPOINT ELEVATION IS LOWER THAN INTERMEDIATE ELEVATION . THE LOW END POINT WAS
EXTRAPOLATED VERTICALLY

OVERTOPPING DISCHARGE CURVE FOR UNSUBMERGED				CONDITION
DEPTH feet	DISCHARGE cfs	AVE. VELOCITY fps	MAX. VELOCITY fps	LENGTH feet
.00	.00	.00	.00	.00
.10	.24	.62	.62	8.09
.20	1.44	.89	.89	16.60
.30	8.61	1.16	1.16	49.58
.40	18.40	1.45	1.47	55.87
.50	31.35	1.69	1.74	62.17
.60	47.26	1.88	1.97	68.46
.70	74.80	2.00	2.23	95.74
.80	102.72	2.19	2.43	95.74
.90	133.84	2.37	2.61	95.74
1.00	169.85	2.57	2.80	95.74
1.10	206.99	2.73	2.96	95.74
1.20	246.62	2.89	3.11	95.74
1.30	289.31	3.05	3.25	95.74
1.40	333.61	3.19	3.39	95.74
1.50	380.02	3.33	3.52	95.74
1.60	428.44	3.46	3.65	95.74
1.70	478.79	3.59	3.77	95.74
1.80	531.00	3.72	3.89	95.74
1.90	585.01	3.84	4.01	95.74
2.00	640.75	3.96	4.12	95.74
2.10	698.17	4.07	4.23	95.74
2.20	757.23	4.18	4.34	95.74
2.30	817.87	4.29	4.45	95.74
2.40	880.06	4.39	4.55	95.74
2.50	943.77	4.50	4.65	95.74
2.60	1008.95	4.60	4.75	95.74
2.70	1075.57	4.70	4.84	95.74
2.80	1143.61	4.79	4.94	95.74
2.90	1213.03	4.89	5.03	95.74
3.00	1283.80	4.98	5.12	95.74
3.10	1355.91	5.07	5.21	95.74
3.20	1429.32	5.16	5.29	95.74
3.30	1504.01	5.25	5.38	95.74
3.40	1579.97	5.33	5.47	95.74
3.50	1657.16	5.42	5.55	95.74
3.60	1735.58	5.50	5.63	95.74
3.70	1815.20	5.59	5.71	95.74
3.80	1896.01	5.67	5.79	95.74
3.90	1977.98	5.75	5.87	95.74
4.00	2061.10	5.83	5.95	95.74
4.10	2145.36	5.91	6.03	95.74
4.20	2230.74	5.98	6.10	95.74
4.30	2317.22	6.06	6.18	95.74
4.40	2404.80	6.13	6.25	95.74
4.50	2493.45	6.21	6.32	95.74
4.60	2583.17	6.28	6.40	95.74
4.70	2673.94	6.36	6.47	95.74
4.80	2765.75	6.43	6.54	95.74
4.90	2858.59	6.50	6.61	95.74
5.00	2952.45	6.57	6.68	95.74

OUTFLOW HYDROGRAPH HAS OVER 200 VALUES

Culvert Analysis: Mill Creek: Project: 17-Mile Road (Existing)

Time 10: 1:42
Date 10/ 7/1999
FILE NAME C:\CDS\MILL.C

CULVERT PRINT OPTION NO. 3

PERFORMANCE

STATION: 66+04.00 PROJECT:
CULVERT SIZE: 1- 112.0 in X 75.0 in
CULVERT TYPE:
METAL PIPE ARCH / UNPAVED /
MITERED-STEP BEVEL INLET
Manning N : .0320 Inlet Loss Coef. : .7000
ANALYSIS TYPE: Q: 1015.0000 cfs FREQ: 25 YR

HYDROGRAPH REVIEW

BARREL GEOMETRY: LENGTH			SLOPE			Flowline Elev.			Overtopping Elev		
ft	%	ft	Inlet	Outlet	ft	ft	ft	ft	ft	ft	
100	.43701		5226.87	5226.43							5236.22

* * * * * CULVERT PERFORMANCE * * * * *

Freq	Peak Discharges	Culvert Data			Upstream	Tailwater	Scour Analysis			Cutoff Wall									
		Inflow	Outflow	Over	Head	Outlet	Flow	Pond	Type	Area	Dur.	Depth	max	Depth	Wid.	Length	Vol.	Depth	Width
yr	cfs	cfs	cfs	ft	fps	ft	no.	ac	min	ft	fps	ft	ft	ft	ft	cy	ft	ft	
25	1015.0	1006.6	468.7	11.0	13.6	4.8	1.1	OM2F	3.	376	4.7	6.2	7.1	10.8	60.	117.	748.	6.3	37.9
100	1747.0	1735.7	1171.0	12.2	12.3	6.2	.9	OM2F	3.	0	6.2	6.2	8.0	11.3	64.	129.	882.	7.2	40.0
0																			

ALL CULVERT TYPES REQUESTED HAVE BEEN REVIEWED

Culvert Analysis: Mill Creek: Project: 17-Mile Road

Time 10: 1:42
Date 10/ 7/99
FILE NAME C:\CDS\MLLC

CULVERT

PRINT OPTION NO. 3

PERFORMANCE

STATION: 66+04.00 PROJECT:
CULVERT SIZE: 2- 96.0 in x 60.0 in

CULVERT TYPE:

CONCRETE BOX/

30 -75 DEGREE WINGWALL INLET & NO BEVEL
Manning N : .0130 Inlet Loss Coef. : .4000

ANALYSIS TYPE:

Q: 1015.0000 cfs FREQ: 25 YR

HYDROGRAPH DESIGN

DESIGN CRITERIA

Allowable Headwater Depth	Greatest Culvert Height ft	Maximum Pond Size ac	HW/D Ratio	Outlet Velocity fps	Overtopping Depth ft	Incipient
9.00	6.00	.00	.00	.00	9.35	

BARREL GEOMETRY: LENGTH ft SLOPE % Flowline Elev. ft
100 .43700 5226.87 5226.43 5236.22

* * * * * C U L V E R T P E R F O R M A N C E * * * * *

Freq	Inflow	Peak Discharges cfs	Outflow	Culvert Data				Upstream Flow Type	Tailwater Pond Area Dur.	Scour Analysis Depth ave max	Cutoff Wall Vol. Leng.	Cutoff Wall Depth Width							
				Head	Outlet Depth	Vel	Depth												
25	1015.0	957.1	582.0	8.8	12.7	4.7	1.0	IS2	2.	347	4.5	6.2	7.0	10.2	64.	107.	616.	6.5	49.0
100	1747.0	1735.3	582.7	11.2	14.4	5.0	1.1	IF	3.	376	6.2	6.2	8.0	11.4	73.	131.	925.	6.1	50.0
0																			

ALL CULVERT TYPES REQUESTED HAVE BEEN DESIGNED

Culvert Analysis: Mill Creek: Project: 17-Mile Road

Time 10: 1:42
Date 10/ 7/1999
FILE NAME C:\CDS\MILL.C

CULVERT

PRINT OPTION NO. 3

PERFORMANCE

STATION: 66+04.00 PROJECT:
CULVERT SIZE: 2- 96.0 in X 72.0 in

CULVERT TYPE:

CONCRETE BOX/

30 -75 DEGREE WINGWALL INLET & NO BEVEL
Manning N : .0130 Inlet Loss Coef. : .4000

ANALYSIS TYPE:

Q: 1015.0000 cfs FREQ: 25 YR

HYDROGRAPH REVIEW

BARREL GEOMETRY: LENGTH			SLOPE	Flowline Elev.			Overtopping Elev
ft	ft	%	ft	Inlet	Outlet	ft	
100	.43701		5226.87	5226.43			5236.22

* * * * * C U L V E R T P E R F O R M A N C E * * * * *

Freq	Peak Discharges	Culvert Data			Upstream			Tailwater			Scour Analysis			Cutoff Wall		
		Inflow	Outflow	Over	Head Depth	Vel Depth	Fr Type	Area Dur.	Depth	Ave max	Depth	Width	Vol.	Leng.	Depth	Width
25	1015.0	980.0	439.0	439.1	8.1	12.7	4.8	1.0	IS2	2.	347	4.6	6.2	7.0	10.3	65.
100	1747.0				11.0	13.5	6.0	1.0	IF	3.	376	6.2	6.2	8.0	11.8	74.
0																635.

ALL CULVERT TYPES REQUESTED HAVE BEEN REVIEWED

Culvert Analysis: Mill Creek: Project: 17-Mile Road

CULVERT DESIGN SYSTEM
Time 10: 1:42
Date 10/ 7/1999
FILE NAME C:\CDS\MILLC

CULVERT PRINT OPTION NO. 3

PERFORMANCE

STATION: 66+04.00 PROJECT:
CULVERT SIZE: 3- 60.0 in x 72.0 in
CULVERT TYPE:
CONCRETE BOX/
30 -75 DEGREE WINGWALL INLET & NO BEVEL
Manning N : .0130 Inlet Loss Coef. : .4000

ANALYSIS TYPE: Q: 1015.0000 cfs FREQ: 25 YR

HYDROGRAPH REVIEW

	Flowline Elev.			Overtopping Elev.		
	Inlet	Outlet	ft	Inlet	Outlet	ft
100	.43701	5226.87	5226.43	5236.22		

* * * * * C U L V E R T P E R F O R M A N C E * * * * *

Freq	Peak Discharges Inflow Outflow Over	Culvert Data			Tailwater			Scour Analysis			Cutoff Wall		
		Head Depth	Outlet Vel	Flow Depth	Upstream Pond	Pond Type	Velocity Area Dur.	Depth ave	max	Depth	Width	Vol.	Depth
25	1015.0	979.9	.0	8.6	12.8	5.1	1.0	IM2	2.	347	6.2	7.0	66.
100	1747.0	1735.4	507.6	11.1	13.6	6.0	1.0	IP	3.	376	6.2	6.2	10.0
0													

ALL CULVERT TYPES REQUESTED HAVE BEEN REVIEWED

Culvert Analysis: Mill Creek: Project: 17-Mile Road

Time 10: 1:42
Date 10/ 7/1999
FILE NAME C:\CDS\MILLC

CULVERT PRINT OPTION NO. 3

PERFORMANCE

STATION: 66+04.00 PROJECT:
CULVERT SIZE: 3- 72.0 in X 72.0 in
CULVERT TYPE:
CONCRETE BOX/
30 -75 DEGREE WINGWALL INLET & NO BEVEL

Manning N : .0130 Inlet Loss Coef. : .4000

ANALYSIS TYPE: Q: 1015.0000 cfs FREQ: 25 YR

HYDROGRAPH REVIEW

BARREL GEOMETRY: LENGTH			SLOPE			Flowline Elev.			Overtopping Elev		
ft	ft	%	ft	ft	ft	Inlet	Outlet				
100	.43701		5226.87	5226.43							

100 .43701 5226.87 5226.43 5236.22

* * * * * C U L V E R T P E R F O R M A N C E * * * * *

* * * * * DOWNSTREAM CHANNEL PERFORMANCE***

Freq	Peak Discharges	Culvert Data			Upstream Flow	Tailwater Pond Area	Velocity Dur.	Scour Analysis Depth	Cutoff Wall Width		
		Inflow	Outflow	Over	Head	Vel	Depth	Type	Ave	Max	Depth
25	1015.0	995.4	0.0	7.7	11.9	4.6	1.0	OM2	2.	343	4.6
100	1747.0	1733.3	306.8	10.7	13.2	5.8	1.0	IF	2.	376	6.2
0											

ALL CULVERT TYPES REQUESTED HAVE BEEN REVIEWED

Culvert Analysis: Mill Creek: Project: 17-Mile Road

Time 10: 1:42
Date 10/ 7/1999
FILE NAME C:\CDS\MILLC

CULVERT PRINT OPTION NO. 3

PERFORMANCE

STATION: 66+04.00 PROJECT:
CULVERT SIZE: 3- 72.0 in X 72.0 in
CULVERT TYPE:
ROUND CONCRETE/
+ Manning N : .0130 Inlet Loss Coef. : .2000
, SOCKET END PROJECTING INLET
ANALYSIS TYPE: Q: 1015.0000 cfs FREQ: 25 YR

HYDROGRAPH DESIGN

DESIGN CRITERIA

Allowable Headwater Depth ft	Greatest Culvert Height ft	Maximum Pond Size ac	Maximum Hw/D Ratio	Outlet Velocity fps	Overtopping Depth ft	Incipient
9.00	6.00	.00	.00	.00	9.35	

BARREL GEOMETRY: LENGTH ft 100
SLOPE % .43700
Flowline Elev. ft 5226.87
Inlet Outlet ft 5226.43
Overtopping Elev. ft 5236.22

* * * * * C U L V E R T P E R F O R M A N C E * * * * *

Freq	Peak Discharges Inflow	Outflow	Over	Culvert Data				Upstream Flow				Tailwater Pond				Scour Analysis				Cutoff Wall			
				Head	Outlet	Depth	Fr	Type	Area	Dur.	Depth	Ave	max	Depth	Wid.	Leng.	Vol.	Depth	Width				
25	1015.0	977.1	0	8.3	13.1	4.9	1.0	IM2	2.	347	4.6	6.2	7.0	9.0	69.	104.	462.	4.6	47.8				
100	1747.0	1735.5	481.6	11.1	14.9	6.0	1.1	IP	3.	376	6.2	6.2	8.0	10.1	78.	127.	710.	4.2	48.8				

OUTFLOW HYDROGRAPH HAS OVER 200 VALUES

* * * * * DOWNTREAM CHANNEL PERFORMANCE ***

Culvert Analysis: Mill Creek: Project: 17-Mile Road

Time 10: 1:42
Date 10/ 7/1999
FILE NAME C:\CDS\MILL.C

CULVERT

PRINT OPTION NO. 3

PERFORMANCE

STATION: 66+04.00 PROJECT:
CULVERT SIZE: 4- 66.0 in X 66.0 in
CULVERT TYPE:
ROUND METAL RIVETED) / UNPAVED /
COMMERCIAL END(FE) INLET

Manning N : .0240 Inlet Loss Coef. : .5000

ANALYSIS TYPE: Q: 1015.0000 cfs FREQ: 25 YR

HYDROGRAPH DESIGN

DESIGN CRITERIA

Allowable Headwater Depth ft	Greatest Culvert Height ft	Maximum Pond Size ac	HW/D Ratio	Maximum Velocity fps	Incipient Overtopping ft
9.00	6.00	.00	.00	.00	9.35

BARREL GEOMETRY: LENGTH ft 100 SLOPE % .43700 FLOWLINE ELEV. ft 5226.87

Outlet ft	Inlet ft	Overtopping Elev. ft
5226.43	5236.22	

* * * * * C U L V E R T P E R F O R M A N C E * * * * *

Freq yr	Peak Discharges cfs	Inflow Outflow Over cfs	Culvert Data			Upstream Flow			Tailwater Pond Velocity			Scour Analysis			Cutoff Wall		
			Head Depth Vel	Outlet Depth Fr	Depth Dur.	Type Area	Depth Dur.	Ave Depth	max	Depth	Width Wid.	Leng.	Vol.	Depth	Width		
25	1015.0	974.3	.0	8.4	11.5	4.6	.9	OM2F	2.	347	4.6	6.2	7.0	8.0	68.	91.	319.
100	1747.0	1726.0	547.8	11.2	12.3	5.5	.9	OF	3.	376	6.2	6.2	8.0	8.9	74.	106.	456.

OUTFLOW HYDROGRAPH HAS OVER 200 VALUES

Culvert Analysis: Mill Creek: Project: 17-Mile Road

Time 10: 1:42

Date 10/ 7/1999

FILE NAME C:\CDS\MILLC

CULVERT

PRINT OPTION NO. 3

PERFORMANCE

STATION: 66+04.00 PROJECT:
CULVERT SIZE: 2- 107.0 in x 68.0 in

CULVERT TYPE:

CONCRETE ELLIPSE(HORIZ AXIS) /

+ Manning N : .0130 Inlet Loss Coef. : .2000 , SOCKET END PROTECTING INLET

ANALYSIS TYPE: Q: 1015.0000 cfs FREQ: 25 YR

HYDROGRAPH DESIGN

DESIGN CRITERIA

Allowable Headwater Depth ft	Greatest Culvert Height ft	Maximum Pond Size ac	Maximum HW/D Ratio	Maximum Outlet Velocity fps	Incipient Overtopping Depth ft
9.00	6.00	.00	.00	.00	9.35

BARREL GEOMETRY: LENGTH ft 100
SLOPE % .43700
Flowline Elev. Inlet ft 5226.87
Outlet ft 5226.43
Overtopping Elev. ft 5236.22

* * * * * C U L V E R T P E R F O R M A N C E * * * * *

Freq Yr	Peak Discharges cfs	Inflow cfs	Head ft	Culvert Data outlet	Upstream Flow			Tailwater Pond			Scour Analysis			Cutoff Wall				
					Depth vel	Depth	Fr	Type	Area Dur.	Depth ave	max	Velocity	Depth	Width	Leng.	Vol.	cy	
25	1015.0	967.8	.0	8.6	12.9	4.8	1.0	IM2	2.	347	4.6	6.2	7.0	10.3	66.	110.	636.	
100	1747.0	1735.6	534.6	11.2	14.8	5.7	1.1	IF	3.	376	6.2	8.0	11.5	75.	135.	980.	6.0	51.6

OUTFLOW HYDROGRAPH HAS OVER 200 VALUES

Culvert Analysis: Mill Creek: Project: 17-Mile Road

Time 10: 1:42
 Date 10/ 7/1999
 FILE NAME C:\CDS\MILLC

CULVERT PRINT OPTION NO. 3

PERFORMANCE

STATION: 66+04.00 PROJECT:

CULVERT SIZE: 1- 144.0 in X 84.0 in

CULVERT TYPE:

CONCRETE BOX/

30 -75 DEGREE WINGWALL INLET & NO BEVEL

Manning N : -0130 Inlet Loss Coef. : .4000

ANALYSIS TYPE:

Q: 1015.0000 cfs FREQ: 25 YR

HYDROGRAPH REVIEW

BARREL GEOMETRY: LENGTH			SLOPE	Flowline Elev.	Overtopping Elev
	ft	%	Inlet	Outlet	ft
100	.43701		5226.87	5226.43	5236.22

* * * * * C U L V E R T P E R F O R M A N C E * * * * *

Freq	Peak Discharges	Culvert Data			Upstream	Tailwater	Scour Analysis	Cutoff Wall									
		Head	Outlet	Flow													
yr	cfs	cfs	ft	fps	ft	no.	ac	min	ft	fps	ft	ft	ft	cy	ft	ft	ft
25	1015.0	961.0	10.1	9.7	15.0	5.3	1.2	IS2	2.	343	4.6	6.2	7.0	12.8	69.	130.	1152.
100	1747.0	1736.6	632.3	11.3	15.3	6.0	1.1	IS2	3.	376	6.2	6.2	8.0	14.3	79.	154.	1709.
0																	

ALL CULVERT TYPES REQUESTED HAVE BEEN REVIEWED

06/30/99

WEST Consultants, Inc.
2111 Palomar Airport Rd.
Suite 180
Carlsbad, CA 92009-1419

Riprap 2.0

Burlington Northern Santa Fe Drainage Report

PROGRAM OUTPUT

HEC-11 Method

Input Parameters:

Run Name: MILL CR Description: Mill Creek

Average Channel Velocity, ft/sec 12.30
Average Flow Depth, ft 4.50
Unit Weight of Stone, lbs/cu ft 165.00
Material Angle of Repose, ° 38.00
Cotangent of Sideslope 2.00
Safety Factor 1.10

Output Results:

Computed D50, ft 1.36

*** Using FHWA Gradation ***

Gradation Class 1/4 ton
Layer Thickness, ft 2.70

Percent Smaller by Size	Rock Size, ft	Rock Size, lbs
D100	2.25	1,000
D50	1.80	500
D10	0.95	75

06/30/99

WEST Consultants, Inc.
2111 Palomar Airport Rd.
Suite 180
Carlsbad, CA 92009-1419

Riprap 2.0

Burlington Northern Santa Fe Drainage Report

PROGRAM OUTPUT

HEC-11 Method

Input Parameters:

Run Name: MILL CR Description: Mill Creek

Average Channel Velocity, ft/sec 12.30
Average Flow Depth, ft 7.93
Unit Weight of Stone, lbs/cu ft 165.00
Material Angle of Repose, ° 38.00
Cotangent of Sideslope 2.00
Safety Factor 1.10

Output Results:

Computed D50, ft 1.02

*** Using FHWA Gradation ***

Gradation Class Light
Layer Thickness, ft 1.95

Percent Smaller by Size	Rock Size, ft	Rock Size, lbs
D100	1.80	500
D50	1.30	200
D10	0.40	5

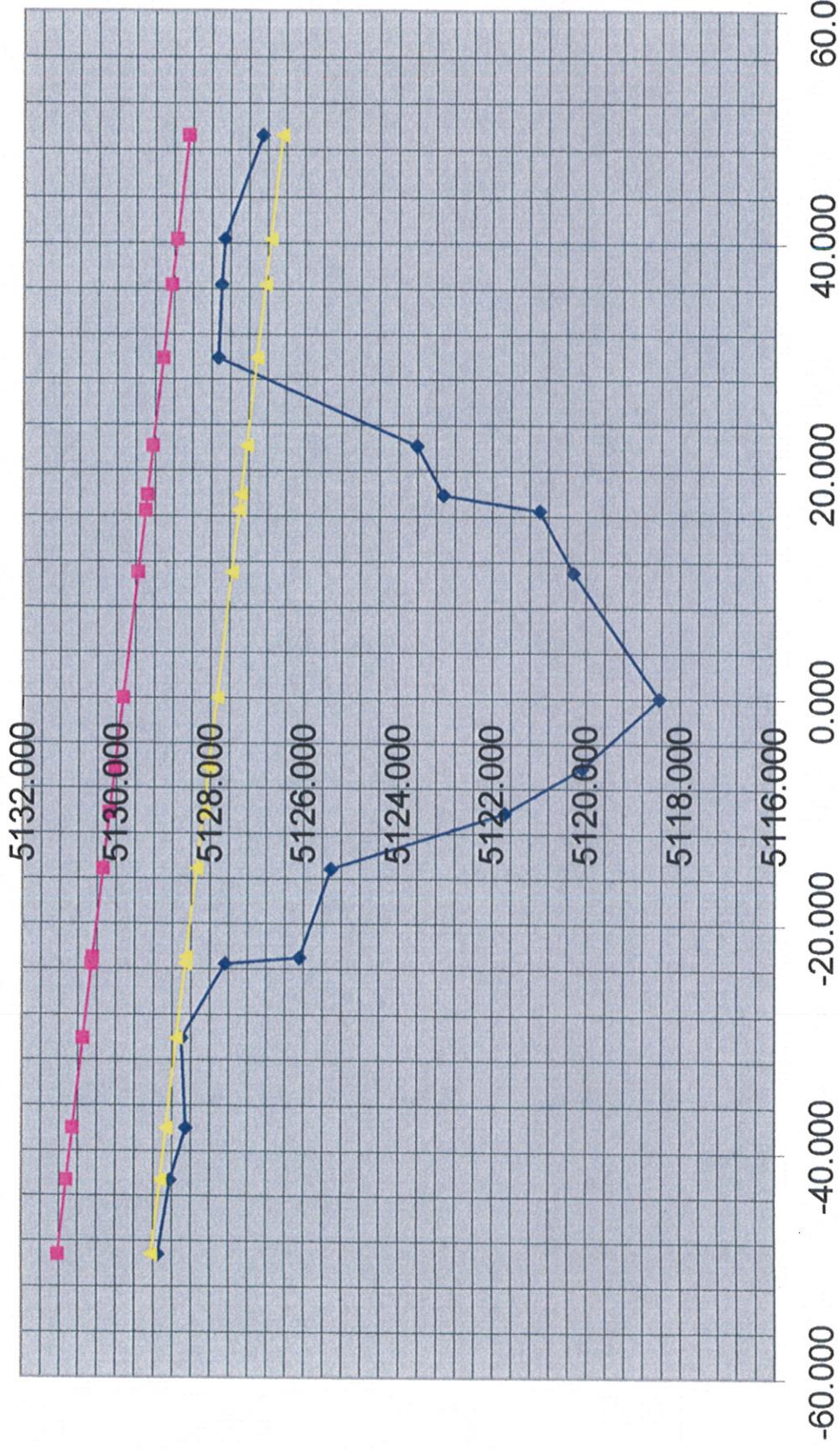
SUB-AGENCY DITCH

HYDRAULICS



SUB-AGENCY DITCH

Channel
Proposed Roadway Profile
Cover Limits



subagcy.txt

JOB Culvert Analysis: Sub-Agency Ditch: Project: 17-Mile Road
PRT 1 1 1 3
SI 1 1
* *****
* ***** Downstream Cross Section for Tailwater Conditions *****
* *** Since this is an Irrigation Canal, not concerned with storage ***
* *****
XS -164 0 0.000527
GR -50.00 5129.79 -49.21 5129.78 -39.46 5129.52 -33.54 5127.31
GR -29.00 5125.16 -20.24 5123.46 -13.16 5122.26 -6.95 5119.19
GR -5.59 5118.41 0.00 5117.80 4.37 5119.40 7.35 5120.29
GR 8.67 5121.64 21.53 5127.20 22.36 5127.81 42.58 5129.79
SA -39.46 22.36
N 0.040 0.030 0.040
* *****
* ***** Road Cross Section Profile *****
* *****
XR 0.00 60 1
GR -50.00 5128.03 0.00 5126.64 50.00 5125.25
* *****
* Culvert Geometry
STA 15380
SL 0.000527 118 5118.129 0 7.121
* Hydrologic Peak Analysis
PD 7.0 6.5
RCB 11
Q 140.74 281
RPD 25 100
SCR 31
RUN
PR 1 12 6.0
RCB 11
RUN
PR 1 10 6.0
RCB 11
RUN
PR 1 9 6.0
RCB 11
RUN
PR 2 5 6.0
RCB 11
RUN
PR 2 6 6.0
RCB 11
RUN
PR 2 4 6.0
RCB 11
RUN
END

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*****  

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**  

**      CCCCCCCCCC      DDDDDDDDDD      SSSSSSSSSS      **  

**      CCCCCCCCCCCC      DDDDDDDDDD      SSSSSSSSSSSS      **  

**      CC      CC      DD      DD      SS      SS      **  

**      CC      DD      DD      SS      **  

**      CC      DD      DD      SSS      **  

**      CC      DD      DD      SSSSSSSS      **  

**      CC      CULVERT      DD      DD DESIGN      SSSSSSSS SYSTEM      **  

**      CC      DD      DD      SSS      **  

**      CC      DD      DD      SS      **  

**      CC      CC      DD      DD      SS      SS      **  

**      CCCCCCCCCCCC      DDDDDDDDDD      SSSSSSSSSSS      **  

**      CCCCCCCCCCCC      DDDDDDDDDD      SSSSSSSSSS      **  

**  

**  

**      METRIC <> ENGLISH VERSION  

**      VERSION 6.1      LEVEL 0      RELEASE DATE 08/98      **  

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Culvert Analysis: Sub-Agency Ditch: Project: 17-Mile Road
 CULVERT DESIGN SYSTEM

Culvert Analysis: Sub-Agency Ditch: Project: 17-Mile Road

Time 15: 1: 6
 Date 7/ 6/1999
 FILE NAME c:\cds\subag

CHANNEL STAGE DISCHARGE RELATIONSHIP

CHANNEL SLOPE = .00053FT/FT
 STAGE DISCHARGE INPUT VERIFICATION

INPUT VERIFIED?

DESIGNER_____

CHECKER_____

X(1) =	-50.0	Y(1) =	5129.8	MANNINGS NUMBER =	.040
X(2) =	-49.2	Y(2) =	5129.8	MANNINGS NUMBER =	.040
X(3) =	-39.5	Y(3) =	5129.5	MANNINGS NUMBER =	.040
X(4) =	-33.5	Y(4) =	5127.3	MANNINGS NUMBER =	.030
X(5) =	-29.0	Y(5) =	5125.2	MANNINGS NUMBER =	.030
X(6) =	-20.2	Y(6) =	5123.5	MANNINGS NUMBER =	.030
X(7) =	-13.2	Y(7) =	5122.3	MANNINGS NUMBER =	.030
X(8) =	-7.0	Y(8) =	5119.2	MANNINGS NUMBER =	.030
X(9) =	-5.6	Y(9) =	5118.4	MANNINGS NUMBER =	.030
X(10) =	.0	Y(10) =	5117.8	MANNINGS NUMBER =	.030
X(11) =	4.4	Y(11) =	5119.4	MANNINGS NUMBER =	.030
X(12) =	7.4	Y(12) =	5120.3	MANNINGS NUMBER =	.030
X(13) =	8.7	Y(13) =	5121.6	MANNINGS NUMBER =	.030
X(14) =	21.5	Y(14) =	5127.2	MANNINGS NUMBER =	.030
X(15) =	22.4	Y(15) =	5127.8	MANNINGS NUMBER =	.030
X(16) =	42.6	Y(16) =	5129.8	MANNINGS NUMBER =	.040

CULVERT DESIGN SYSTEM
CHANNEL STAGE DISCHARGE RELATIONSHIP

CHANNEL SLOPE = .00053FT/FT
STAGE DISCHARGE INPUT VERIFICATION

VERIFIED?	CHECKER_____	INPUT						
		DESIGNER_____	VELOCITY	ELEVATION	DEPTH	DISCHARGE	VELOCITY	MAX.
feet	feet	cfs	fps	fps				
5117.80		.00	.00	.00			.00	
5118.10		.30	.17	.32			.32	
5118.41		.61	1.13	.51			.59	
5118.71		.91	3.36	.73			.85	
5119.19		1.39	9.22	1.00			1.17	
5119.40		1.60	12.67	1.09			1.28	
5119.70		1.90	18.54	1.21			1.43	
5120.00		2.20	25.78	1.31			1.57	
5120.29		2.49	34.19	1.41			1.71	
5120.59		2.79	45.13	1.54			1.87	
5120.89		3.09	57.49	1.66			2.02	
5121.19		3.39	71.26	1.77			2.16	
5121.49		3.84	94.69	1.92			2.35	
5121.94		4.14	111.26	2.00			2.45	
5122.26		4.46	130.86	2.08			2.56	
5122.56		4.76	147.59	2.10			2.60	
5122.86		5.06	166.97	2.13			2.66	
5123.16		5.36	189.09	2.17			2.74	
5123.46		5.66	214.09	2.22			2.82	
5123.76		5.96	242.82	2.27			2.92	
5124.06		6.26	274.47	2.33			3.02	
5124.36		6.56	309.17	2.39			3.12	
5124.66		6.86	347.01	2.45			3.23	
5124.96		7.16	388.13	2.51			3.33	
5125.16		7.36	417.60	2.55			3.40	
5125.46		7.66	469.20	2.64			3.54	
5125.76		7.96	523.87	2.73			3.67	
5126.06		8.26	581.67	2.81			3.79	
5126.36		8.56	642.63	2.90			3.90	
5126.66		8.86	706.79	2.98			4.02	
5126.96		9.16	774.20	3.06			4.13	
5127.20		9.40	830.82	3.12			4.21	
5127.31		9.51	858.05	3.15			4.25	
5127.61		9.81	933.39	3.23			4.36	
5127.81		10.01	985.53	3.28			4.42	
5128.11		10.31	1071.93	3.37			4.55	
5128.41		10.61	1162.16	3.45			4.66	
5128.71		10.91	1256.52	3.52			4.78	
5129.01		11.21	1355.26	3.58			4.89	
5129.31		11.51	1458.58	3.64			4.99	
5129.52		11.72	1534.33	3.68			5.07	
5129.78		11.98	1642.69	3.74			5.19	
5129.79		11.99	1646.85	3.74			5.19	

CULVERT DESIGN SYSTEM

``` Culvert Analysis: Sub-Agency Ditch: Project: 17-Mile Road

| ROADWAY PROFILE COORDINATES |           |
|-----------------------------|-----------|
| STATION                     | ELEVATION |
| feet                        | feet      |
| -50.0                       | 5128.0    |
| .0                          | 5126.6    |
| 50.0                        | 5125.3    |

ROADWAY ENDPOINT ELEVATION IS LOWER THAN INTERMEDIATE ELEVATION . THE LOW END POINT WAS EXTRAPOLATED VERTICALLY

| OVERTOPPING DISCHARGE CURVE FOR UNSUBMERGED |           |               |               | CONDITION |
|---------------------------------------------|-----------|---------------|---------------|-----------|
| DEPTH                                       | DISCHARGE | AVE. VELOCITY | MAX. VELOCITY | LENGTH    |
| feet                                        | cfs       | fps           | fps           | feet      |
| .00                                         | .00       | .00           | .00           | .00       |
| .10                                         | .05       | .62           | .62           | 1.71      |
| .20                                         | .31       | .89           | .89           | 3.51      |
| .30                                         | .90       | 1.15          | 1.15          | 5.31      |
| .40                                         | 1.87      | 1.33          | 1.33          | 7.11      |
| .50                                         | 3.23      | 1.46          | 1.46          | 8.91      |
| .60                                         | 5.12      | 1.60          | 1.60          | 10.71     |
| .70                                         | 7.55      | 1.73          | 1.73          | 12.51     |
| .80                                         | 10.56     | 1.85          | 1.85          | 14.31     |
| .90                                         | 14.21     | 1.97          | 1.97          | 16.11     |
| 1.00                                        | 18.51     | 2.07          | 2.07          | 17.91     |
| 1.10                                        | 24.07     | 2.23          | 2.23          | 19.71     |
| 1.20                                        | 29.95     | 2.33          | 2.33          | 21.51     |
| 1.30                                        | 36.61     | 2.42          | 2.42          | 23.31     |
| 1.40                                        | 88.38     | 2.52          | 2.52          | 50.11     |
| 1.50                                        | 108.78    | 2.71          | 2.71          | 51.91     |
| 1.60                                        | 130.07    | 2.86          | 2.88          | 53.72     |
| 1.70                                        | 152.88    | 3.00          | 3.03          | 55.52     |
| 1.80                                        | 177.19    | 3.13          | 3.18          | 57.32     |
| 1.90                                        | 203.05    | 3.25          | 3.32          | 59.12     |
| 2.00                                        | 230.44    | 3.37          | 3.46          | 60.92     |
| 2.10                                        | 259.39    | 3.48          | 3.59          | 62.72     |
| 2.20                                        | 289.88    | 3.58          | 3.71          | 64.52     |
| 2.30                                        | 321.93    | 3.68          | 3.84          | 66.32     |
| 2.40                                        | 356.00    | 3.78          | 3.95          | 68.12     |
| 2.50                                        | 391.32    | 3.87          | 4.07          | 69.92     |
| 2.60                                        | 428.25    | 3.96          | 4.18          | 71.72     |
| 2.70                                        | 466.79    | 4.04          | 4.29          | 73.52     |
| 2.80                                        | 552.52    | 3.92          | 4.39          | 100.00    |
| 2.90                                        | 606.39    | 4.02          | 4.50          | 100.00    |
| 3.00                                        | 661.66    | 4.11          | 4.60          | 100.00    |
| 3.10                                        | 718.88    | 4.21          | 4.70          | 100.00    |
| 3.20                                        | 777.96    | 4.30          | 4.79          | 100.00    |
| 3.30                                        | 838.84    | 4.40          | 4.89          | 100.00    |
| 3.40                                        | 901.45    | 4.49          | 4.98          | 100.00    |
| 3.50                                        | 965.76    | 4.58          | 5.07          | 100.00    |
| 3.60                                        | 1031.70   | 4.67          | 5.16          | 100.00    |
| 3.70                                        | 1099.24   | 4.76          | 5.25          | 100.00    |
| 3.80                                        | 1168.33   | 4.85          | 5.34          | 100.00    |
| 3.90                                        | 1238.94   | 4.94          | 5.42          | 100.00    |
| 4.00                                        | 1311.02   | 5.02          | 5.51          | 100.00    |
| 4.10                                        | 1384.56   | 5.11          | 5.59          | 100.00    |
| 4.20                                        | 1459.52   | 5.20          | 5.67          | 100.00    |
| 4.30                                        | 1535.87   | 5.28          | 5.75          | 100.00    |
| 4.40                                        | 1613.58   | 5.36          | 5.83          | 100.00    |
| 4.50                                        | 1692.63   | 5.44          | 5.91          | 100.00    |
| 4.60                                        | 1773.00   | 5.52          | 5.99          | 100.00    |
| 4.70                                        | 1854.66   | 5.60          | 6.06          | 100.00    |
| 4.80                                        | 1937.60   | 5.68          | 6.14          | 100.00    |
| 4.90                                        | 2021.79   | 5.76          | 6.21          | 100.00    |
| 5.00                                        | 2107.21   | 5.84          | 6.29          | 100.00    |

Culvert Analysis: Sub-Agency ditch: Project: 17-Mile Road  
 Time 15: 1: 6  
 Date 7/ 6/1999  
 FILE NAME c:\cds\subag

#### CULVERT PRINT OPTION NO. 3

##### PERFORMANCE

STATION: 153+8 .00 PROJECT:  
 CULVERT SIZE: 1- 48.0 in X 48.0 in

##### CULVERT TYPE:

##### CONCRETE BOX/

##### 30 -75 DEGREE WINGWALL INLET & NO BEVEL

Manning N : .0130 Inlet Loss Coef. : .4000

ANALYSIS TYPE: Q: 140.7400 cfs FREQ: 25 YR

##### PEAK DESIGN

##### DESIGN CRITERIA

| Allowable Headwater Depth ft | Greatest Culvert Height ft | Maximum Pond Size ac | Maximum HW/D Ratio | Incipient Overtopping Velocity ft fps |
|------------------------------|----------------------------|----------------------|--------------------|---------------------------------------|
| 7.00                         | 6.50                       | .00                  | .00                | .00 7.12                              |

| BARREL GEOMETRY: LENGTH ft | SLOPE % | Flowline Elev. |           | Overtopping Elev |
|----------------------------|---------|----------------|-----------|------------------|
|                            |         | Inlet ft       | Outlet ft |                  |
| 118                        | .05270  | 5118.13        | 5118.07   | 5125.25          |

\* \* \* \* \* C U L V E R T P E R F O R M A N C E \* \* \* \* \*

| Freq yr | Peak Discharges cfs | Inflow cfs | Outflow Over | Culvert Data |                 |        |        | Upstream Flow Type | Tailwater Pond Area Dur. | Velocity Depth ave max | Scour Analysis Depth Wid. Leng. | Cutoff Wall Vol. Depth Width |                                            |
|---------|---------------------|------------|--------------|--------------|-----------------|--------|--------|--------------------|--------------------------|------------------------|---------------------------------|------------------------------|--------------------------------------------|
|         |                     |            |              | Head ft      | Outlet Depth ft | Vel ft | fps ft |                    |                          |                        |                                 |                              |                                            |
| 25      | 140.7               | 140.7      | .0           | 6.7          | 8.8             | 4.0    | .8     | OF no.             | 0. ac min                | 4.6 ft                 | 2.1 ft                          | 7.7 ft                       | 36. ft                                     |
| 100     | 281.0               | 281.0      | 130.6        | 8.7          | 9.4             | 4.0    | .8     | OF 0.              | 0. 0.                    | 6.3 0.                 | 2.3 0.                          | 10.1 3.0                     | 81. 105. 12. 28. 105. 10. 12. 28. 7.1 30.0 |

ALL CULVERT TYPES REQUESTED HAVE BEEN DESIGNED

\* \* \* \* \* DOWNSTREAM CHANNEL PERFORMANCE \*\*\*

Culvert Analysis: Sub-Agency Ditch: Project: 17-Mile Road  
 Time 15: 1: 6  
 Date 7/ 6/1999  
 FILE NAME c:\cds\subag

#### CULVERT DESIGN SYSTEM

STATION: 153+8 .00 PROJECT:  
 CULVERT SIZE: 1- 144.0 in X 72.0 in  
 CULVERT TYPE:  
 CONCRETE BOX/  
 30 -75 DEGREE WINGWALL INLET & NO BEVEL  
 Manning N : .0130 Inlet Loss Coef. : .4000

#### CULVERT OPTION NO. 3

##### PERFORMANCE

BARREL GEOMETRY: LENGTH ft SLOPE %  
 118 .05255  
 Flowline Elev. Overtopping Elev  
 Inlet ft Outlet ft  
 5118.13 5118.07 5125.25

##### PEAK REVIEW

ANALYSIS TYPE: Q: 140.7400 cfs FREQ: 25 YR

##### PERFORMANCE

| Freq | Inflow yr | Peak Discharges cfs | Outflow cfs | Over | CULVERT PERFORMANCE |              |     |       |           |                |         |               |          |           | DOWNSTREAM CHANNEL PERFORMANCE |             |            |             |           |             |
|------|-----------|---------------------|-------------|------|---------------------|--------------|-----|-------|-----------|----------------|---------|---------------|----------|-----------|--------------------------------|-------------|------------|-------------|-----------|-------------|
|      |           |                     |             |      | Head Depth          | Outlet Depth | Vel | Depth | Flow Type | Pond Area Dur. | Flow Fr | Upstream Pond | Velocity | Tailwater | Scour Analysis                 | Depth Depth | Width Wid. | Leng. Leng. | Vol. Vol. | Depth Depth |
| 25   | 140.7     | 140.7               | .0          | 4.7  | 2.5                 | 4.6          | .2  | 0.1   | 0.        | 0              | 4.6     | 2.1           | 2.6      | 7.1       | 28.                            | 68.         | 9.         | 5.5         | 18.7      |             |
| 100  | 281.0     | 281.0               | .0          | 6.6  | 3.9                 | 5.9          | .3  | 0F    | 0.        | 0              | 6.3     | 2.3           | 3.0      | 9.6       | 39.                            | 93.         | 22.        | 7.3         | 25.9      |             |

Culvert Analysis: Sub-Agency Ditch: Project: 17-Mile Road  
 Time 15: 1: 6  
 Date 7/ 6/1999  
 FILE NAME c:\cds\subag

#### CULVERT PRINT OPTION NO. 3

##### PERFORMANCE

STATION: 153+8 .00 PROJECT:  
 CULVERT SIZE: 1- 120.0 in X 72.0 in  
 CULVERT TYPE:  
 CONCRETE BOX/  
 30 -75 DEGREE WINGWALL INLET & NO BEVEL  
 Manning N : .0130 Inlet Loss Coef. : .4000

ANALYSIS TYPE: Q: 140.7400 cfs FREQ: 25 YR

##### PEAK REVIEW

| Flowline Elev. |        |         | Overtopping Elev |         |        |
|----------------|--------|---------|------------------|---------|--------|
|                | Inlet  | Outlet  |                  | Inlet   | Outlet |
|                | ft     | ft      |                  | ft      | ft     |
| 118            | .05255 | 5118.13 | 5118.07          | 5125.25 |        |

\* \* \* \* \* C U L V E R T P E R F O R M A N C E \* \* \* \* \*

| Freq | Peak Discharges | Culvert Data |        |           | Upstream Flow | Tailwater Pond Type | Velocity Depth Ave Max | Scour Analysis Depth Wid. Leng. | Vol. Depth Width | DOWNSTREAM CHANNEL PERFORMANCE*** |     |       |      |       |      |       |
|------|-----------------|--------------|--------|-----------|---------------|---------------------|------------------------|---------------------------------|------------------|-----------------------------------|-----|-------|------|-------|------|-------|
|      |                 | Head         | Outlet | Depth Vel |               |                     |                        |                                 |                  | Depth                             | Max | Depth | Wid. | Leng. | Vol. | Depth |
| yr   | cfs             | cfs          | ft     | fps       | ft            | ac                  | min                    | ft                              | fps              | ft                                | ft  | ft    | ft   | ft    | ft   | ft    |
| 25   | 140.7           | 140.7        | .0     | 4.8       | 3.0           | 4.6                 | .2                     | 0M1                             | 0.               | 0                                 | 4.6 | 2.1   | 2.6  | 7.2   | 29.  | 70.   |
| 100  | 281.0           | 281.0        | .0     | 6.8       | 4.7           | 5.9                 | .3                     | OF                              | 0.               | 0                                 | 6.3 | 2.3   | 3.0  | 9.7   | 41.  | 96.   |

| Freq | Inflow Outflow Over | Culvert Data |        |           | Upstream Flow | Tailwater Pond Type | Velocity Depth Ave Max | Scour Analysis Depth Wid. Leng. | Vol. Depth Width | DOWNSTREAM CHANNEL PERFORMANCE*** |     |       |      |       |      |       |
|------|---------------------|--------------|--------|-----------|---------------|---------------------|------------------------|---------------------------------|------------------|-----------------------------------|-----|-------|------|-------|------|-------|
|      |                     | Head         | Outlet | Depth Vel |               |                     |                        |                                 |                  | Depth                             | Max | Depth | Wid. | Leng. | Vol. | Depth |
| yr   | cfs                 | cfs          | ft     | fps       | ft            | ac                  | min                    | ft                              | fps              | ft                                | ft  | ft    | ft   | ft    | ft   | ft    |
| 25   | 140.7               | 140.7        | .0     | 4.8       | 3.0           | 4.6                 | .2                     | 0M1                             | 0.               | 0                                 | 4.6 | 2.1   | 2.6  | 7.2   | 29.  | 70.   |
| 100  | 281.0               | 281.0        | .0     | 6.8       | 4.7           | 5.9                 | .3                     | OF                              | 0.               | 0                                 | 6.3 | 2.3   | 3.0  | 9.7   | 41.  | 96.   |

Culvert Analysis: Sub-Agency ditch: Project: 17-Mile Road  
 Time 15: 1: 6  
 Date 7/ 6/1999  
 FILE NAME c:\cds\subag

#### CULVERT PRINT OPTION NO. 3

##### PERFORMANCE

STATION: 153+8 .00 PROJECT:  
 CULVERT SIZE: 1- 108.0 in x 72.0 in  
 CULVERT TYPE:  
 CONCRETE BOX/  
 30 -75 DEGREE WINGWALL INLET & NO BEVEL  
 Manning N : .0130 Inlet Loss Coef. : .4000  
 ANALYSIS TYPE: Q: 140.7400 cfs FREQ: 25 YR

##### PEAK REVIEW

| BARREL GEOMETRY: LENGTH |        |    | SLOPE   | Flowline Elev. |    |         | Overtopping Elev |
|-------------------------|--------|----|---------|----------------|----|---------|------------------|
| ft                      | %      | ft | Inlet   | Outlet         | ft | ft      |                  |
| 118                     | .05255 |    | 5118.13 | 5118.07        |    | 5125.25 |                  |

\* \* \* \* \* C U L V E R T P E R F O R M A N C E \* \* \* \* \*

| Freq | Peak Discharges | Culvert Data |         |      | Upstream |        |       | Tailwater |      |      | Scour Analysis |      |      | Cutoff Wall |     |     |       |
|------|-----------------|--------------|---------|------|----------|--------|-------|-----------|------|------|----------------|------|------|-------------|-----|-----|-------|
|      |                 | Inflow       | Outflow | Over | Head     | Outlet | Depth | Flow      | Pond | Type | Fr             | Area | Dur. | Depth       | Ave | Max | Depth |
| yr   | cfs             | cfs          | cfs     | ft   | fps      | ft     | ft    | no.       | ac   | min  | ft             | fps  | ft   | ft          | ft  | cy  | ft    |
| 25   | 140.7           | 140.7        | 0       | 4.9  | 3.4      | 4.6    | .3    | 0M1       | 0.   | 0    | 4.6            | 2.1  | 2.6  | 7.3         | 30. | 71. | 10.   |
| 100  | 281.0           | 281.0        | 0       | 6.9  | 5.2      | 5.9    | .4    | OF        | 0.   | 0    | 6.3            | 2.3  | 3.0  | 9.8         | 42. | 97. | 24.   |